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TITLE Metrics in Education - Resource Materials.  
INSTITUTION New York State Education Dept., Albany. Div. of Curriculum Development.; Western Michigan Univ., Kalamazoo. Center for Metric Education.  
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## ABSTRACT

This publication contains materials suitable for reproduction as transparencies or as classroom handouts. These metric materials may be used in a variety of occupational and practical arts courses. The format of the materials is in large print, some with humorous drawing; details of drawings and charts are easy to read. Introductory pages deal with all units of metric measures but the primary emphasis is upon linear uses of metric measures. Specific topics include: reading a metric micrometer and a vernier caliper, tables of metric hardware sizes, diagrams of metric hardware (nuts, bolts, screws, wrenches, etc.), master dimensioning, dual dimensioning, conversion tables, metric sizes of softwood, orthographic projection comparisons (first and third angle), paper sizes and weights, and printer's units. (JBW)

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# metrics in education

## RESOURCE MATERIALS



2

THE UNIVERSITY OF THE STATE OF NEW / THE STATE EDUCATION DEPARTMENT

Division of Curriculum Development/Albany, New York 12234

719 964

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# FOREWORD

The United States is going metric. Acceptance by business and industry as a necessity for world trade is accelerating the shift to metrics. All teachers in this State should be assessing their part in this change process. The Commissioner of Education has issued a policy statement endorsing metric instruction to prepare students to live in a metric world.

The metric system is really very simple. It is based on tens. Changing from one multiple or sub-multiple of a unit to another is accomplished by multiplying or dividing by ten. Changeover is presently on a voluntary basis, but is part of a worldwide trend. Over 90 percent of the world's population live in metric countries, or ones which are changing to metrics.

Three strategies are basic to instruction in metrics.

- The Need to Know

All people will need to know the basics of the metric system of measurement but not everyone will need to know all about metrics. Students will need, those terms and practices necessary to substitute for present measurement instruction. It is not necessary to memorize metric symbols, prefixes, base units, or derived units before the information is relevant to ongoing instruction.

- Metric First

The recommended format for writing measurements is to give the size, mass, or distance in correct metric terms followed by the customary measurement in brackets, if it is necessary. Thus twenty centimeters would be written 20 cm (7 7/8"). Using metric first will promote the concept of rounding off in metric just as we now do with customary measurements.

- Compare, Don't Convert

Compare or estimate distances, sizes, mass, or temperatures while learning the new system of measurement. Arithmetic conversions will not lead to facility with metrics.

In the belief that an immediate resource was needed, Arthur J. Dudley, Chief of the Bureau of Industrial Arts, initiated action resulting in this publication. These metric resources were compiled from materials developed by the Center for Metric Education, Western Michigan University. Selections were made by Jarvis Baillargeon, assisted by the staff of the Bureau of Industrial Arts. Robert H. Bielefeld, Director, Division of Occupational Education Instruction, recognized the use of these materials in a variety of occupational and practical arts courses.

These master sheets are being distributed to library media resource staff in each secondary and occupational school in the State for the local production of instructional handouts or overhead transparencies. Their use in schools will facilitate the preparation of learners to adequately handle the metric system in common measurements.

G. Earl Hay, *Supervisor*  
*Bureau of Occupational and Career*  
*Curriculum Development*

Gordon E. Van Hooft, *Director*  
*Division of Curriculum Development*

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This publication contains materials for the local production of transparencies or classroom instructional materials. It is a resource for lesson planning for metric instruction. The material is in the public domain and may be reproduced for classroom use.



# *INTERNATIONAL SYSTEM OF UNITS (SI)*

## *Seven Base Units*

- 1. Metre: Unit of length*
- 2. Kilogram: Unit of mass*
- 3. Second: Unit of time*
- 4. Ampere: Unit of electric current*
- 5. Celsius: Unit of temperature*
- 6. Candela: Unit of luminous intensity*
- 7. Mole: Unit of amount of substance*

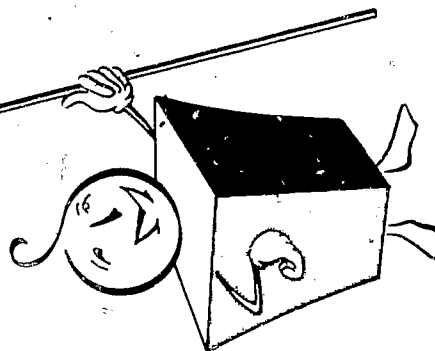


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*In the metric system  
there is a definite relationship  
between units*

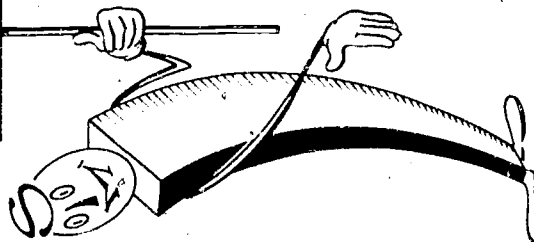
**VOLUME**

= one litre  
- equals



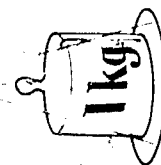
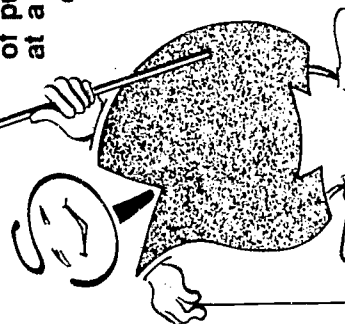
**CAPACITY**

= one cubic  
decimeter  
- contains



**MASS or  
WEIGHT**

= one kilogram  
of pure water  
at a temperature  
of 4°C.

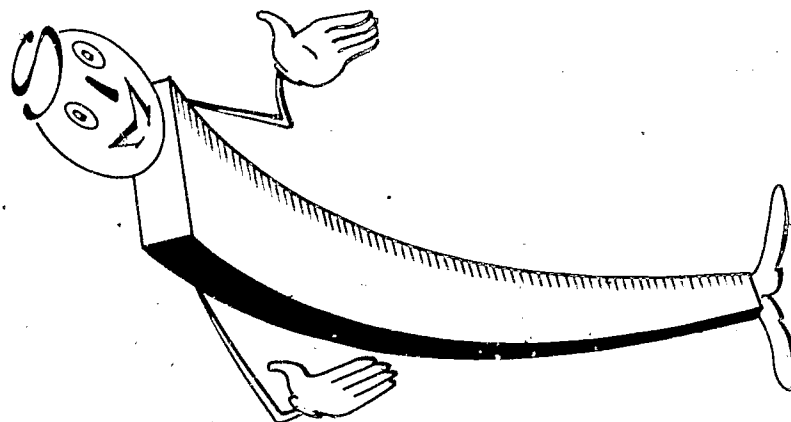






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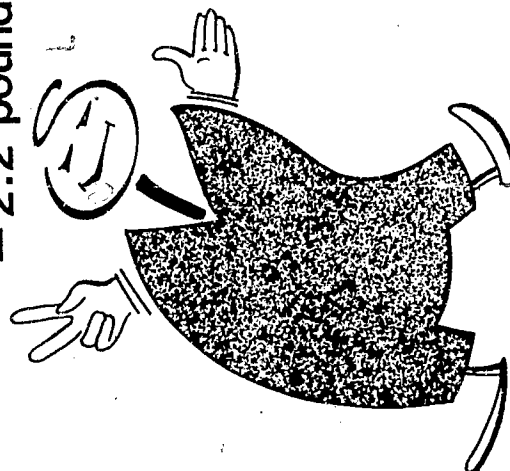
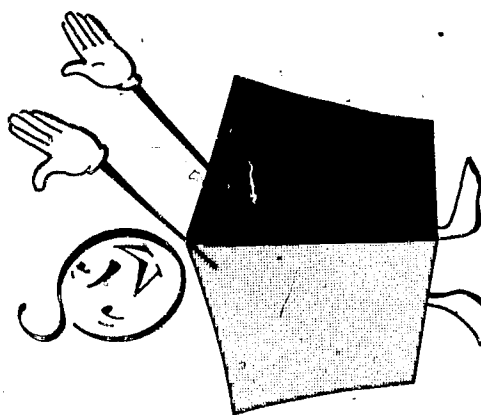
## THREE MEASUREMENTS to REMEMBER



**THE metre**  
is a little longer  
than a yard —  
— 39.37 inches.

**THE litre**  
is a little larger  
than a quart  
— about 6%

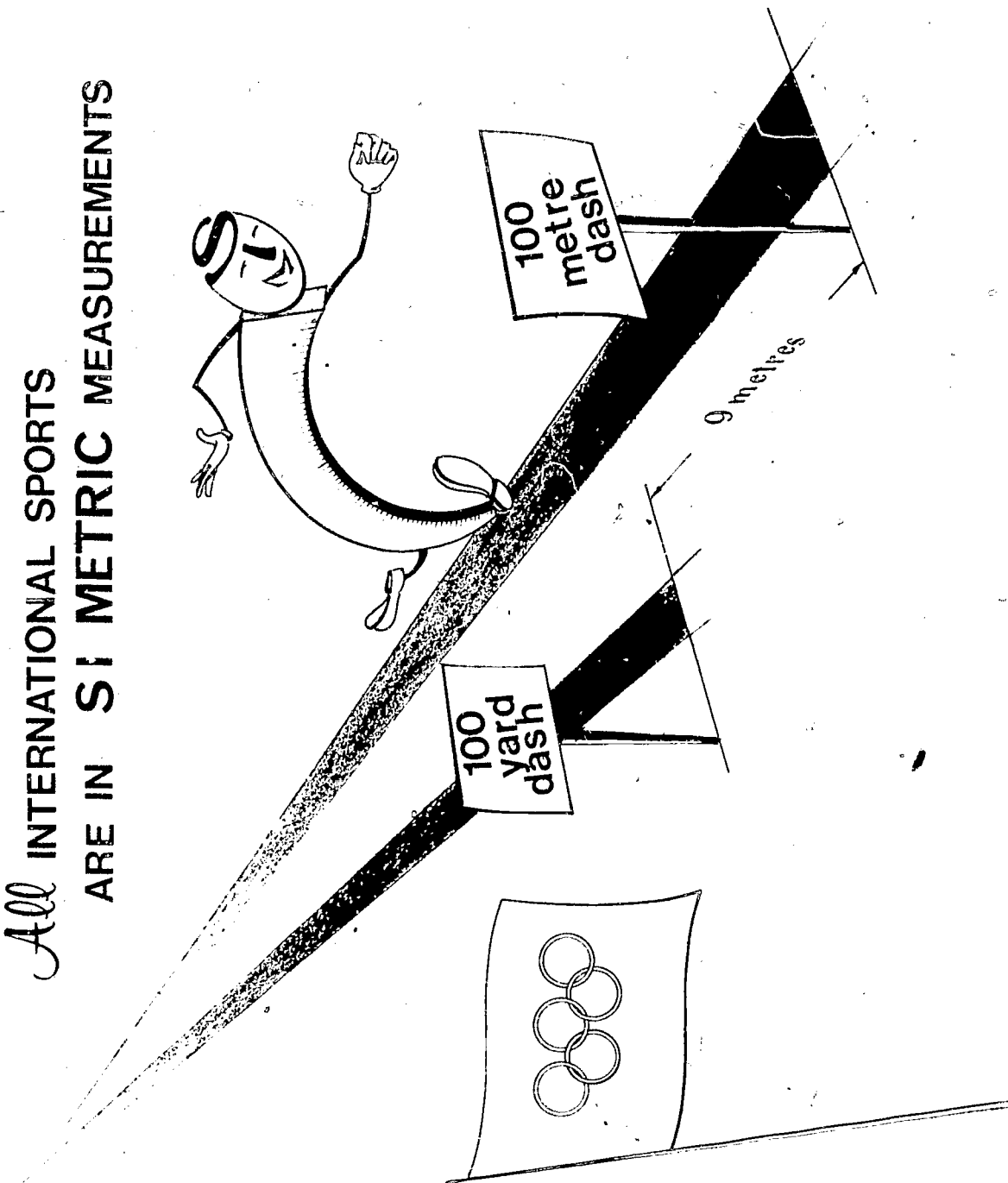
**THE kilogram**  
is a little more  
than twice the pound  
— 2.2 pounds





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# *All* INTERNATIONAL SPORTS ARE IN SI METRIC MEASUREMENTS





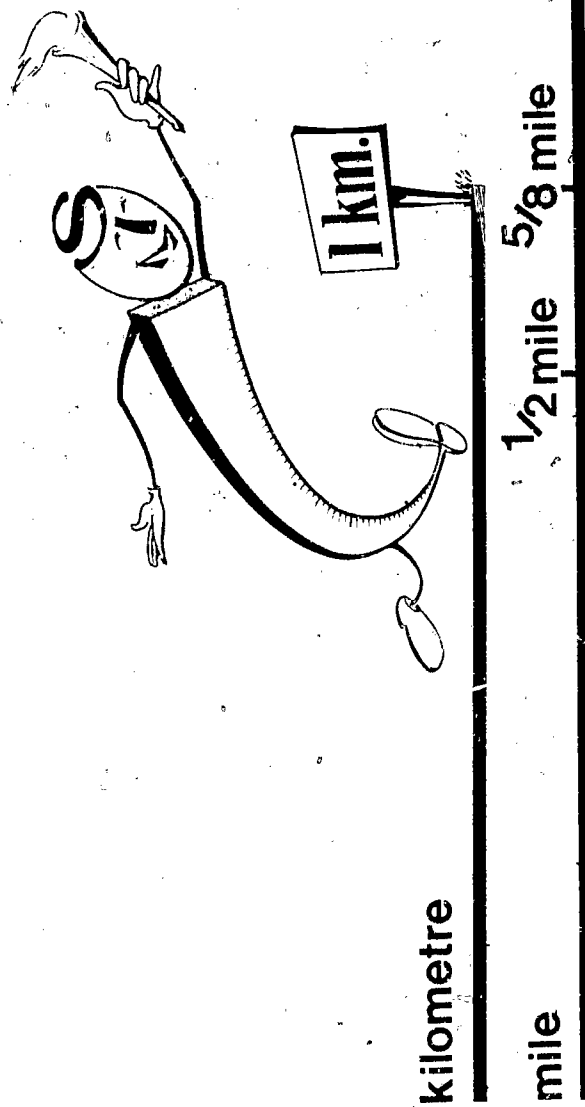
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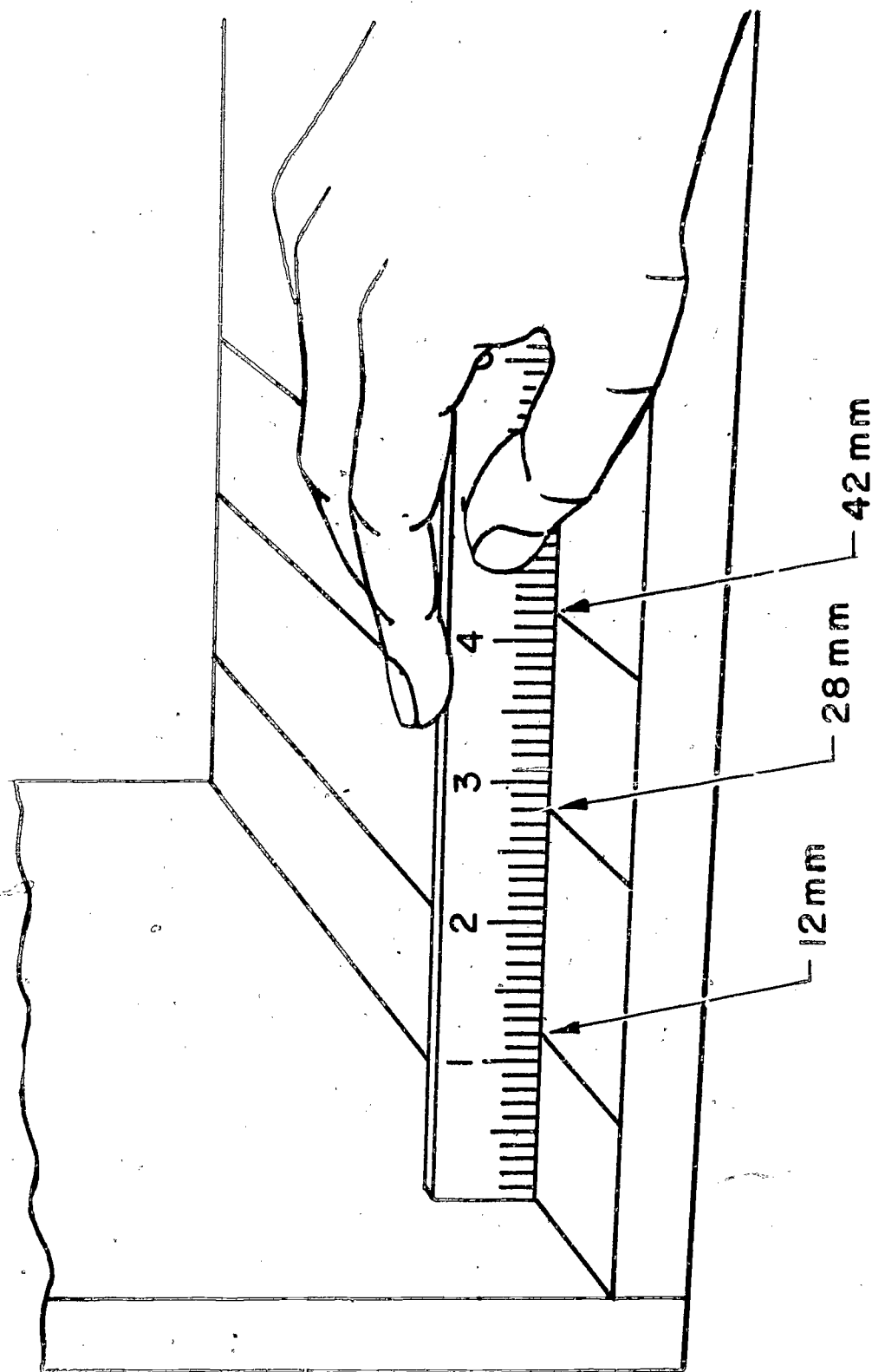
# A kilometre

- is used for long distances..

1000 metres equal one kilometre (km).

A kilometre is about  $\frac{5}{8}$  of a mile.







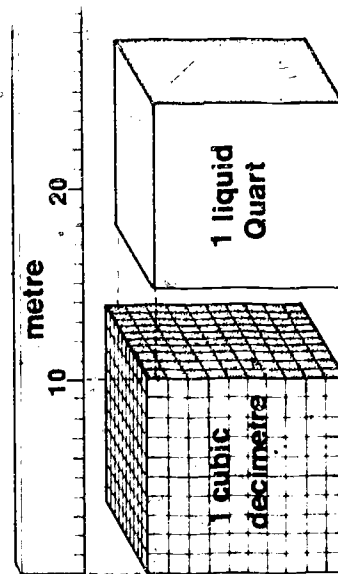
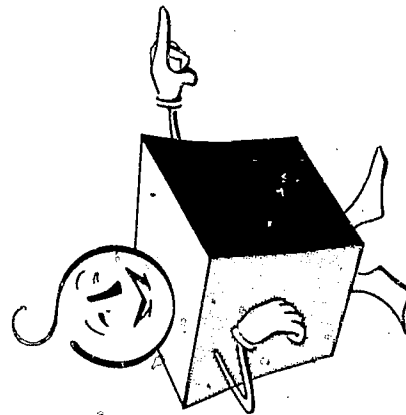
# Meet FIRST COUSIN Litre

## the derived unit of volume.

The litre is equal to one cubic decimetre ( $1 \text{ dm}^3$ )  
or 1 000 cubic centimetres ( $1000 \text{ cm}^3$ )  
or 1 000 000 cubic millimetres ( $1\,000\,000 \text{ mm}^3$ )

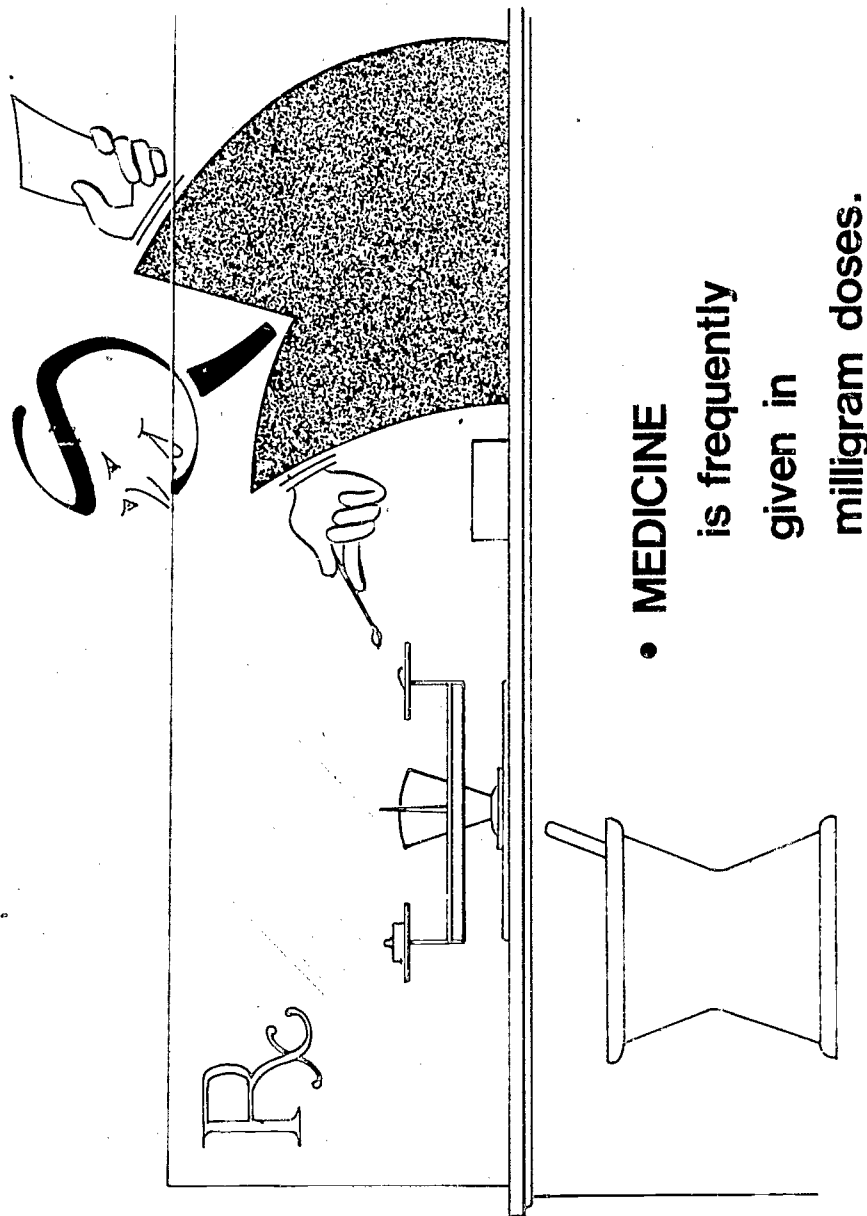
The litre is used for measuring liquids such as water,  
milk, paint, oil and many others.

The litre is slightly more (about 6%) than a quart.





For very small weights  
the milligram (mg) is used.  
1 milligram = 0.001 gram





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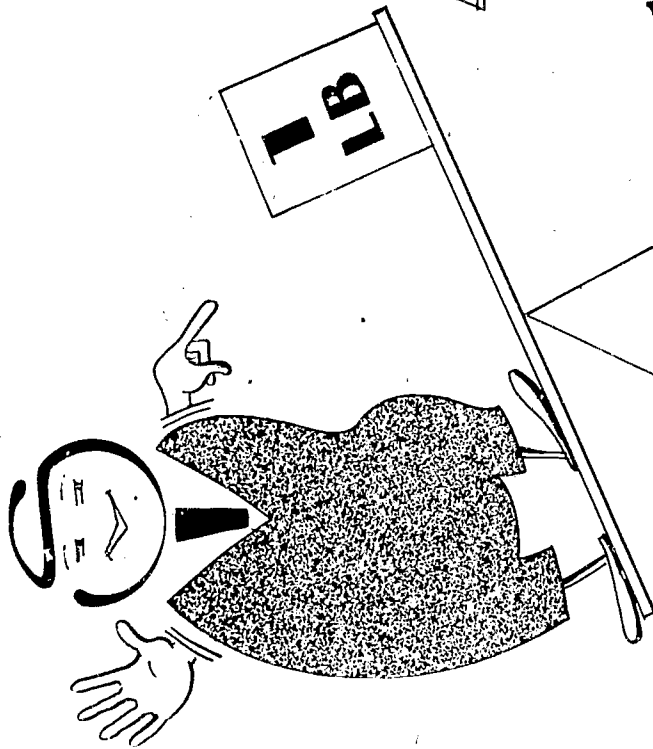
# A NICKEL weighs about five grams



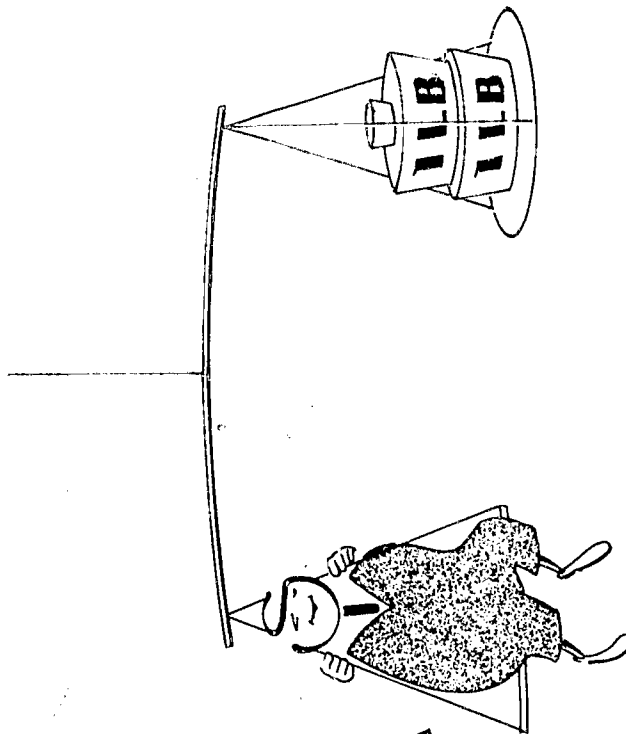


## I'M BROTHER KILOGRAM

I'm much heavier  
than a pound!



I weight about  
2.2 pounds.

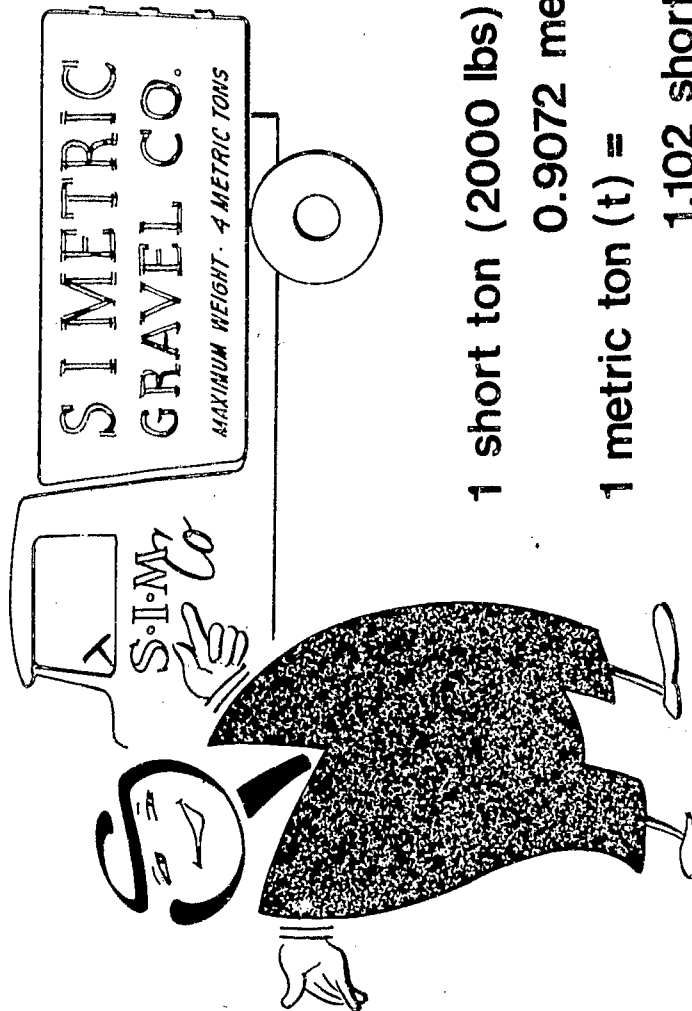


1 pound = 0.4536 kilograms  
1 kilogram = 2.2046 pounds





For greater weights --  
the metric ton (t) is used.  
1 metric ton = 1000 kilograms  
or about 2200 pounds



1 short ton (2000 lbs) =  
0.9072 metric tons  
1 metric ton (t) =  
1.102 short tons



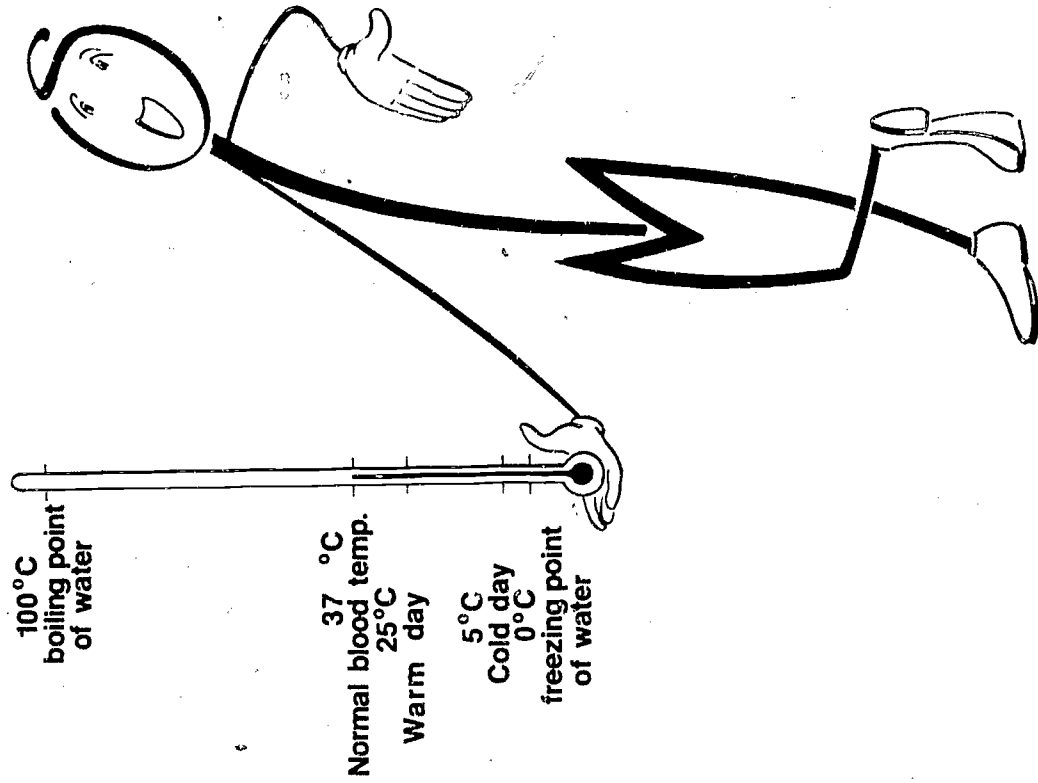
## SISTER Celsius TEMPERATURE

The common metric unit  
for **TEMPERATURE** is  
the degree Celsius.  
It is identical to  
the degree Centigrade.

The symbol is  $^{\circ}\text{C}$

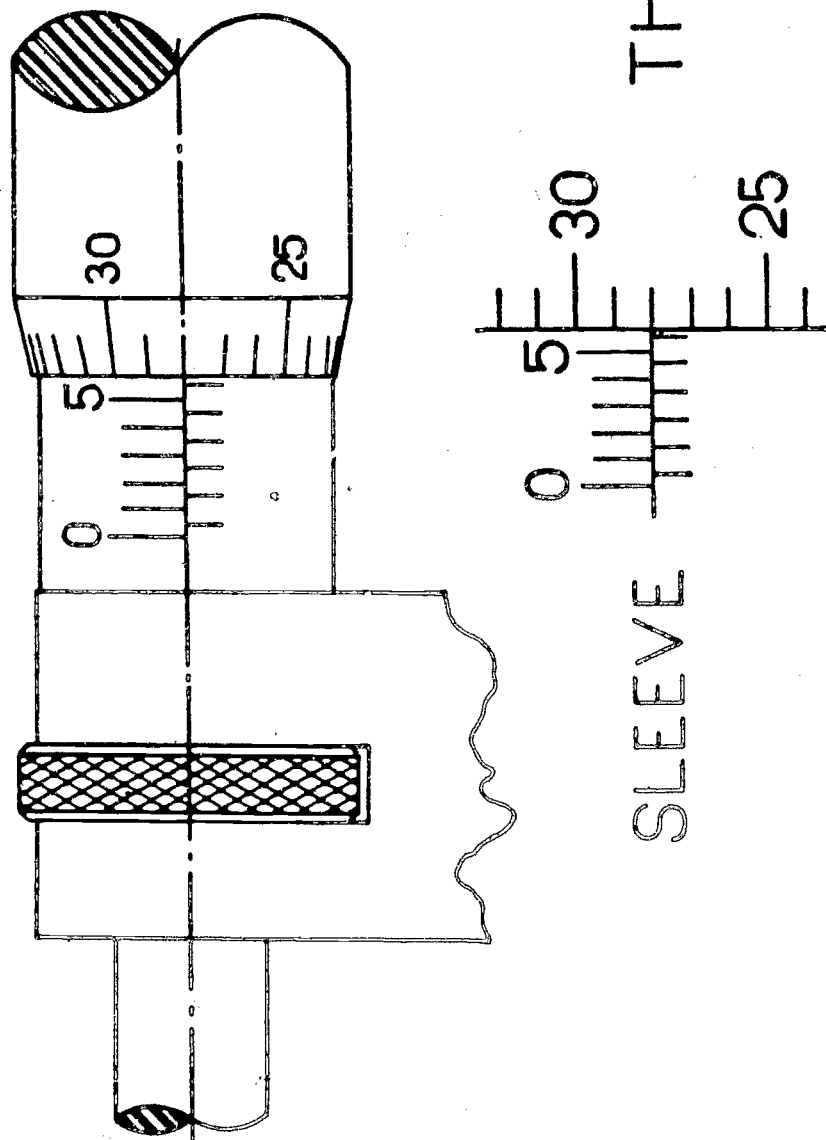
Two common reference  
temperatures are

- $100^{\circ}\text{C}$  boiling point of water
- $0^{\circ}\text{C}$  freezing point of water.





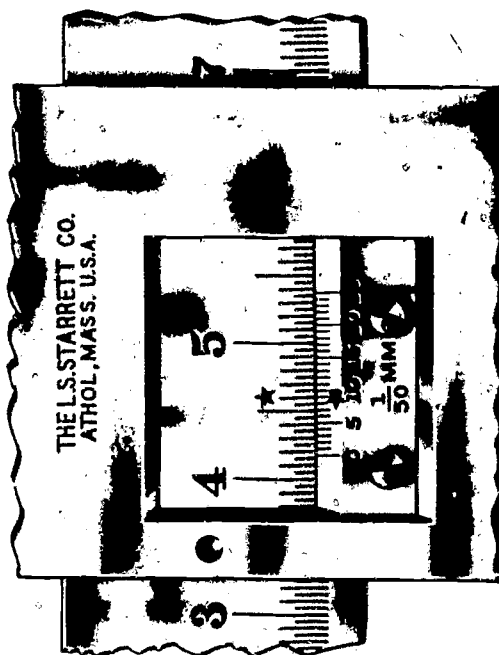
## READING A METRIC MICROMETER





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## METRIC VERNIER CALIPER



The correct reading is:

41.00 mm
0.50 mm
0.18 mm (9/50 mm)
<hr/>
Total 41.68 mm

**ISO Metric Thread—Coarse Series**

Diameter ...	...	2	2.5	3	4	5	6	8	10
Pitch	...	0.4	0.45	0.5	0.7	0.8	1.0	1.25	1.5
Basic effective diameter	...	1.740	2.208	2.675	3.545	4.480	5.350	7.188	9.026
Depth of thread in screw		0.25	0.28	0.31	0.43	0.49	0.61	0.77	0.92
Area of Root dia. (mm <sup>2</sup> )	...	1.79	2.98	4.47	7.75	12.7	17.9	32.8	52.3
Diameter of tapping drill		1.6	2.05	2.5	3.3	4.2	5.0	6.8	8.5

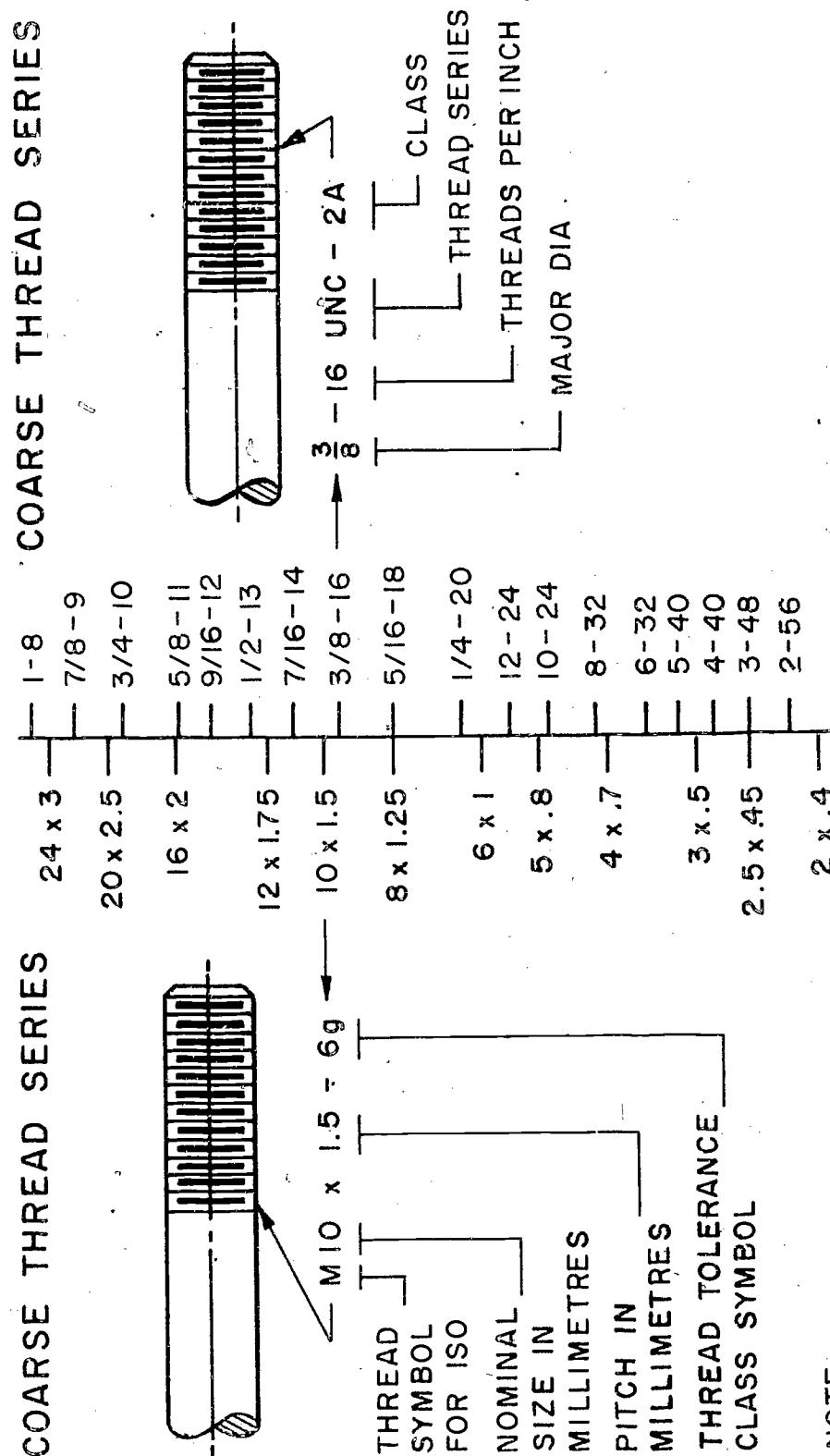
Diameter ...	...	12	16	20	24	30	36	42	48
Pitch	...	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0
Basic effective diameter	...	10.863	14.701	18.376	22.051	27.727	33.402	39.077	44.752
Depth of thread in screw		1.07	1.23	1.53	1.84	2.15	2.45	2.76	3.07
Area of Root dia. (mm <sup>2</sup> )	...	76.2	144	225	324	519	759	1050	1380
Diameter of tapping drill		10.2	14.0	17.5	21.0	26.5	32.0	37.5	43.0

**ISO Metric Thread—Fine Series**

Diameter ...	...	8	10	12	14	16	18	20
Pitch ...	...	1.0	1.25	1.25	1.5	1.5	1.5	1.5
Basic effective dia.	...	7.350	9.188	11.188	13.026	15.026	17.026	19.026
Depth of thread in screw		0.61	0.77	0.77	0.92	0.92	0.92	0.92
Area of Root dia. (mm <sup>2</sup> ) ...		36.0	56.3	86.0	116	157	205	259
Diameter of tapping drill		7.0	8.8	10.8	12.5	14.5	16.5	18.5

Diameter ...	...	22	24	30	36	42	48
Pitch ...	...	1.5	2.0	2.0	3.0	3.0	3.0
Basic effective diameter ...		21.026	22.701	28.701	34.051	40.051	46.051
Depth of thread in screw		0.92	1.23	1.23	1.84	1.84	1.84
Area of Root dia. (mm <sup>2</sup> ) ...		319	365	586	820	1210	1540
Diameter of tapping drill		20.5	22.0	28.0	33.0	39.0	45.0

**ISO METRIC THREAD      UNIFIED NATIONAL**

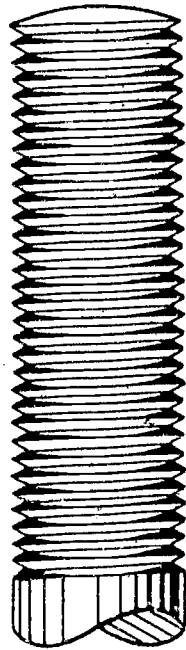


NOTE-  
2 x .4 —  
THE METRIC THREAD ILLUSTRATED IS A LITTLE LARGER IN DIAMETER THAN 3/8" AND HAS ALMOST 17 THREADS PER INCH.



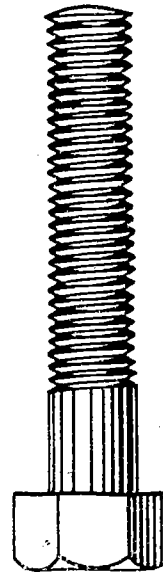
## THREADS:

### EXTERNAL



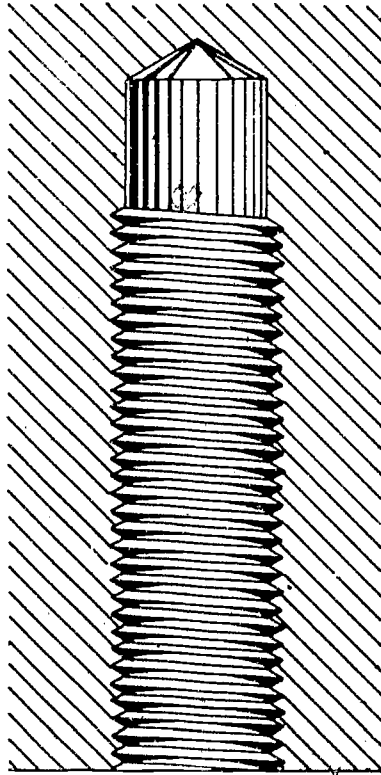
M12 X 1.75 — 6g

### SCREWS & BOLTS



M12 — 6g

### INTERNAL



M12 X 1.75 — 6H

### NUTS



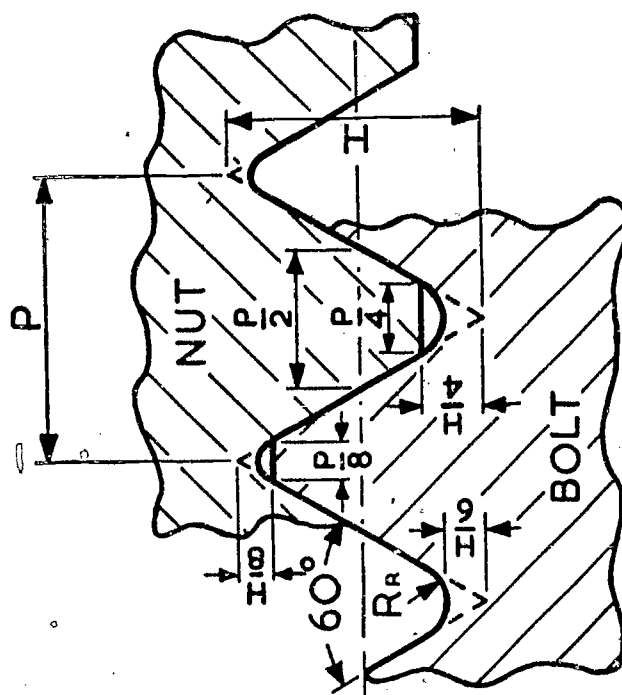
M12 — 6H

CLASS OF FIT	TOLERANCE CLASS	
	Bolts & Screws	Nuts
Medium	6g	6H





## ISO METRIC THREAD FORM



$P = \text{PITCH in mm}$

$H = 0.86603P$

$\frac{H}{4} = 0.21651P$

$\frac{H}{6} = 0.14434P$        $\frac{H}{8} = 0.10825P$

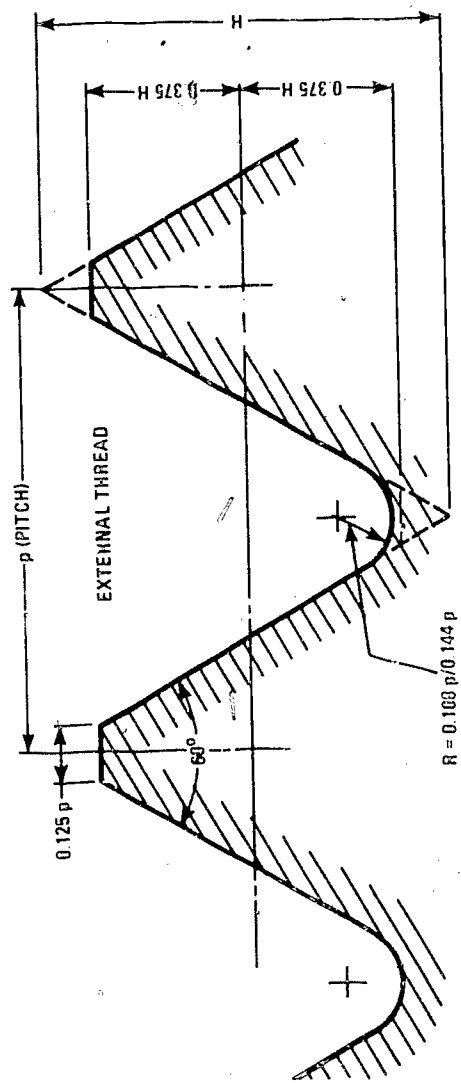
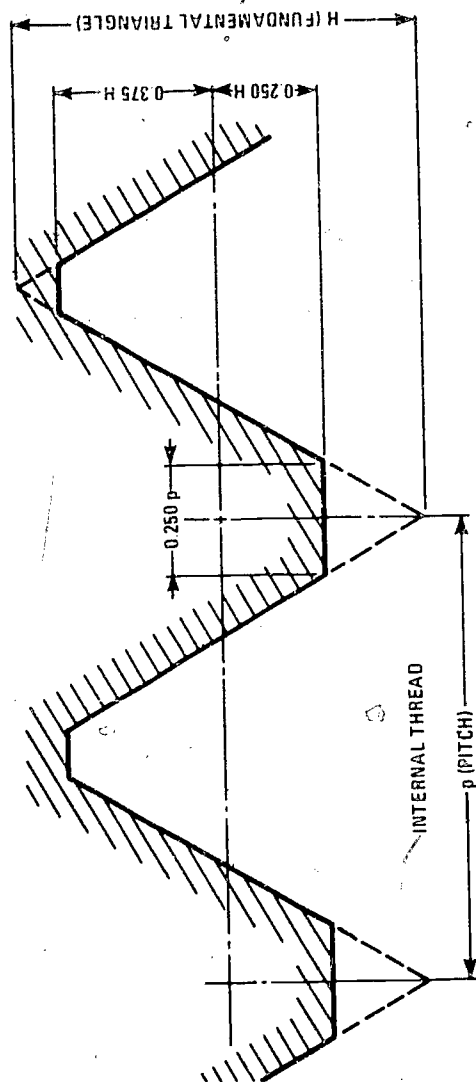
$R_R = 0.14434P$

Depth of thread in screw =  $\frac{17}{24} H = 0.61343P$

Depth of thread in nut =  $\frac{5}{8} H = 0.54127P$

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THREAD FORM - ISO METRIC AND ISO INCH SERIES



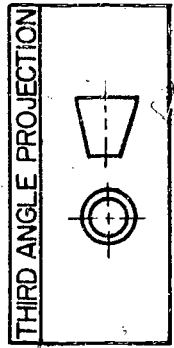
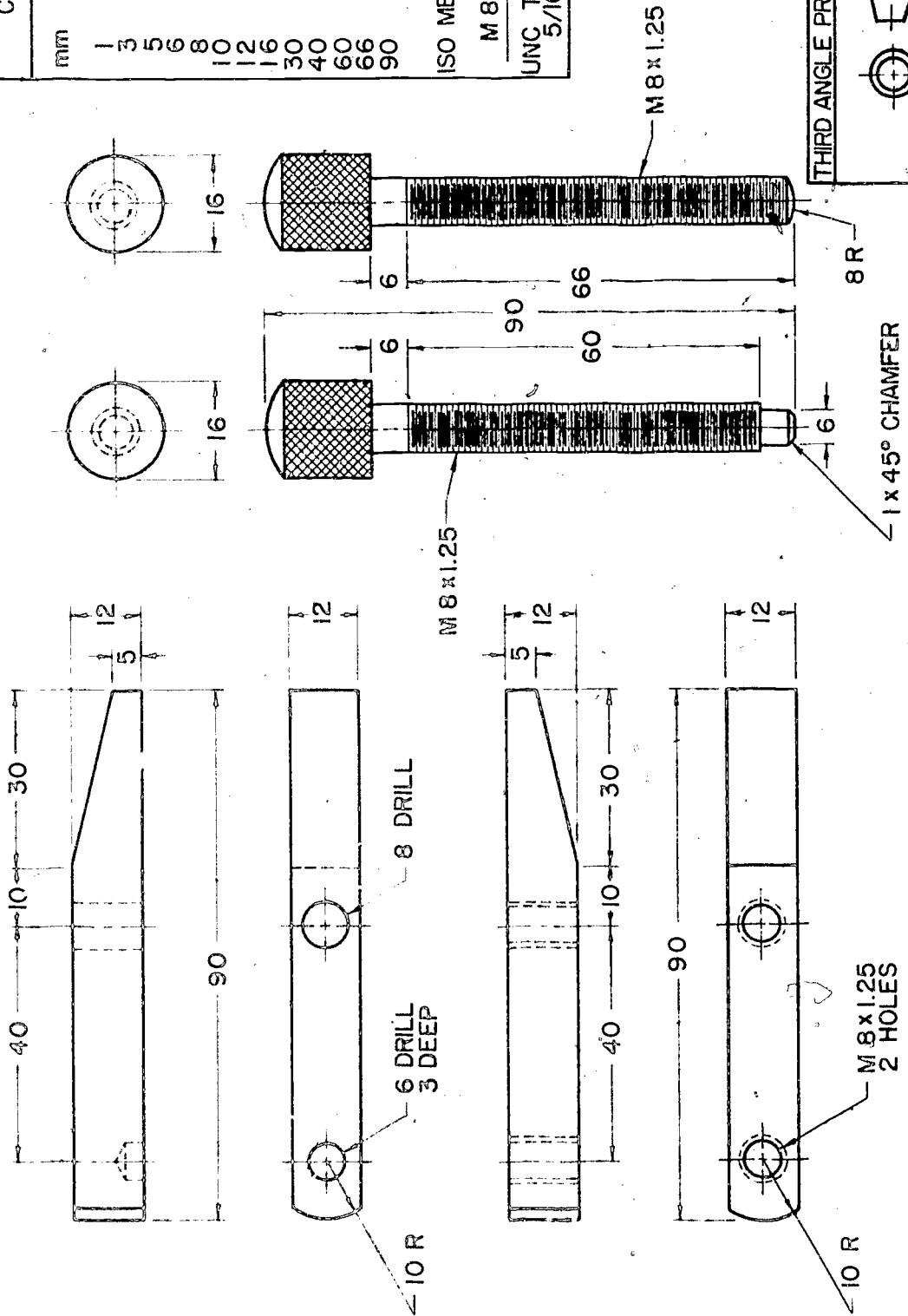


## METRIC DRAWING - METALWORKING (TOOLMAKER'S CLAMP)

CONVERSION CHART	
mm	inch
1	0.039
3	0.118
5	0.197
6	0.236
8	0.315
10	0.394
12	0.472
16	0.630
30	1.181
40	1.575
60	2.362
66	2.598
90	3.543

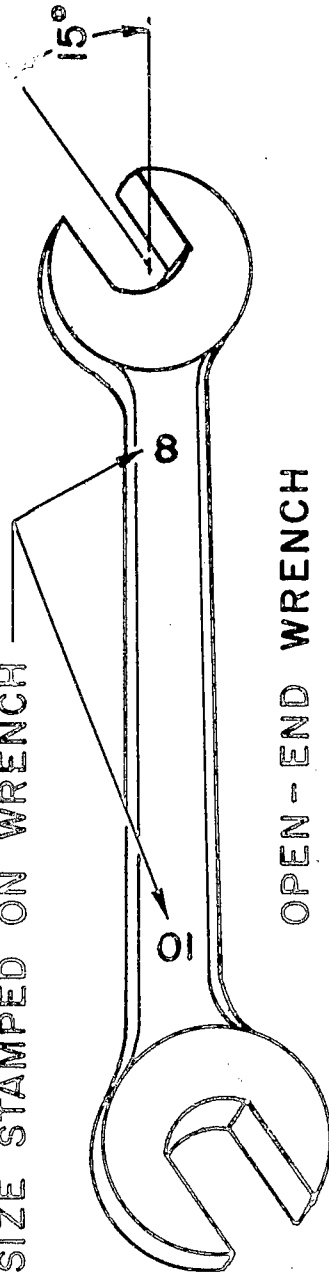
  

ISO METRIC THREAD M 8 x 1.25
UNC THREAD 5/16-18-UNC



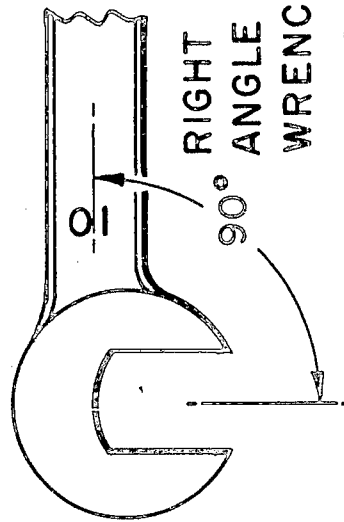


SIZE STAMPED ON WRENCH



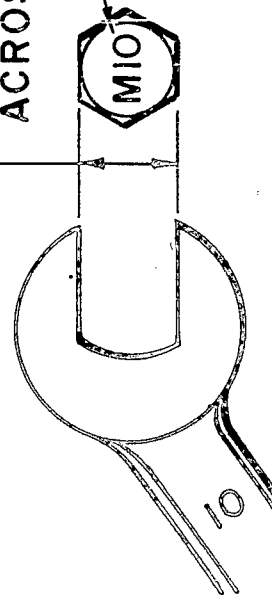
OPEN-END WRENCH

MIO METRIC WRENCH FOR MIO BOLT.  
(DO NOT CONFUSE WITH INCH SIZE  
WRENCHES. 10mm IS BETWEEN A 3/8<sup>th</sup>  
AND 7/16<sup>th</sup> WRENCH IN SIZE.)

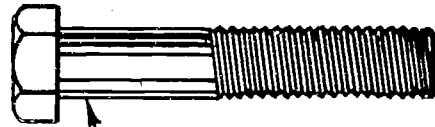


RIGHT  
ANGLE  
90°  
WRENCH

DISTANCE  
ACROSS FLATS



SOMETIMES SIZE  
"MIO" IS STAMPED  
ON HEAD OF BOLT.



MIO x 1.5

**Temperatures, Steel Colors, and Related Processes**

	Colors	F	°C	Processes
Heat Colors	White	2500° 2400°	1371° 1315°	Welding
	Yellow-White	2300° 2200° 2100°	1259° 1204° 1149°	
	Yellow	2000° 1900°	1093° 1036°	High speed steel hardening (1177-1343°C)
	Orange-Red	1800° 1700°	981° 926°	
	Light cherry red	1600° 1500°	871° 815°	Alloy tool steel hardening (816-1066°C)
	Cherry red	1400° 1300°	760° 704°	
	Dark red	1200° 1100°	643° 593°	Carbon tool steel hardening (732-843°C)
	Very dark red	1000° 900° 800°	538° 482° 426°	
	Black red in dull light or darkness	700°	371°	High speed steel tempering (538-593°C)
	Pale blue (310°C)	600°	315°	
Temper Colors	Violet (285°C)	500°	260°	Carbon tool steel tempering (149-566°C)
	Purple (274°C)	400°	204°	
	Yellowish-Brown (254°C)	300°	149°	Carbon tool steel tempering (149-566°C)
	Dark straw (241°C)	200°	93°	
	Light straw (218°C)	100°	38°	Carbon tool steel tempering (149-566°C)
		0°	18°	



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ISO METRIC		ISO INCH		COMPARISON OF NUMBER DIA/PITCH COMBINATIONS	
FINE THREAD SERIES	COARSE THREAD SERIES	COARSE THREAD SERIES	FINE THREAD SERIES		
	100x6	4.4			
	95x6	3 3/4-4			
	90x6	3 1/2-4			
	85x6	3 1/4-4			
	80x6	3-4			
	76x6				
	72x6	2 3/4-4			
	68x6				
	64x6	2 1/2-4			
	60x5.5				
	56x5.5	2 1/4-4 1/2			
	52x5	2.4 1/2			
	48x5				
	45x4.5	1 3/4-5			
	42x4.5				
	39x4	1 1/2-6	1 1/2-12		
36x3	36x4	1 3/8-6	1 3/8-12		
33x2	33x3.5	1 1/4-7	1 1/4-12		
30x2	30x3.5	1 1/8-7	1 1/8-12		
27x2	27x3	1.8	1-12		
24x2	24x3				
22x1.5	22x2.5	7/8-9	7/8-14		
20x1.5	20x2.5				
18x1.5	18x2.5	3/4-10	3/4-16		
16x1.5	16x2	5/8-11	5/8-18		
14x1.5	14x2	9/16-12	9/16-18		
12x1.25	12x1.75	1/2-13	1/2-20		
		7/16-14	7/16-20		
10x1.25	10x1.5	3/8-16	3/8-24		
8x1	8x1.25	5/16-18	5/16-24		
	7x1				
	6x1	1/4-20	1/4-28		
		12-24	12-28		
	5x0.8	10-24	10-32		
	4.5x.75	8-32	8-36		
	4x.7	6-32	6-40		
	3.5x.6	5-40	5-44		
	3x.5	4-40	4-48		
	2.5x.45	3-48	3-56		
	2.2x.45	2-56	2-64		
	2x.4				
		1.64	1.72		
	1.6x.35				
	1.4x.3		0.80		
	1.2x.25		00.96		
1	1x.25				

Metric

Inch

DIAMETERS LARGER THAN 18mm

DIAMETERS 6mm THRU 18mm

DIAMETERS SMALLER THAN 6mm

TOTAL

COMPARISON  
OF ISO INCH, ISO METRIC,  
AND RECOMMENDED  
METRIC DIAMETER/PITCH  
COMBINATIONS

000 120

USOE SPONSORED PROJECT NO. V257006  
GRANT NO. O EG-0-72-1868

PROBABLE BASIC METRIC SIZES OF SOFTWOOD LUMBER SURFACED FOUR SIDES -  
U.S.A.

The following chart shows a close approximation to probable American lumber sizes. This chart is designed to show how we might proceed with our lumber conversions in this country; that is, by converting to the nearest millimetre equivalent. For example, in the .75" or 3/4" standard, we might adopt a 19 mm size. It would be hoped, however, that we would have the good sense to round these off to the nearest millimetre in order to make them more easy with which to work. For example, a piece of half inch lumber might become 15 mm instead of 13 and a piece of 3/4" lumber might become 20 instead of 19, slightly larger in each case. Note that the same thing holds true with the metric length equivalent. We may have to retain direct metric equivalents for customary sizes for repair and modeling reasons. For example, we may have to continue to make sheets of plywood 1.22 m by 2.44 m which is, of course, the metric equivalent for the 4' x 8' sheets of plywood. The reason for this continuance would be to accommodate stud placement in a wall section. When it comes to determining the lengths for lumber, we will probably select a 1.80 m length to approximate 6'; a 2.40 m length to approximate 8'; 3.00 m for 10'; 3.60 m for 12'; 4.2 m for 14'; 4.8 m for 16'; 5.4 m for 18'; and 6.1 m for 20'. Because there is no movement in the United States to determine metric lumber sizes, the chart should be considered for study and discussion purposes only.

**Probable Basic Metric Sizes of Softwood****Lumber Surfaced Four Sides****U.S.A.**

Thickness		Width in mm						
Approx.								
Inches	mm	50	75	100	150	200	250	300
.5	13	x	x	x	x	x	x	x
.75	19	x	x	x	x	x	x	x
1	25	x	x	x	x	x	x	x
1.5	38	x		x	x	x	x	x
2	50	x		x	x	x	x	x
4	100	x		x	x	x	x	x
6	150	x		x	x	x	x	x
8	200	x		x	x	x	x	x
10	250	x		x	x	x	x	x
12	300	x		x	x	x	x	x
Length: 1.83 m (6') 2.44 m (8') 3.05 m (10') 3.66 m (12')								
4.27 m (14') 4.88 m (16') 5.49 m (18') 6.10 m (20')								

Probable 4' x 8' Panel Size: 1220 mm x 2440 mm, or  
1.22 m x 2.44 m





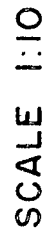
# BORING CHART FOR WOOD SCREWS

Customary and Metric Sizes

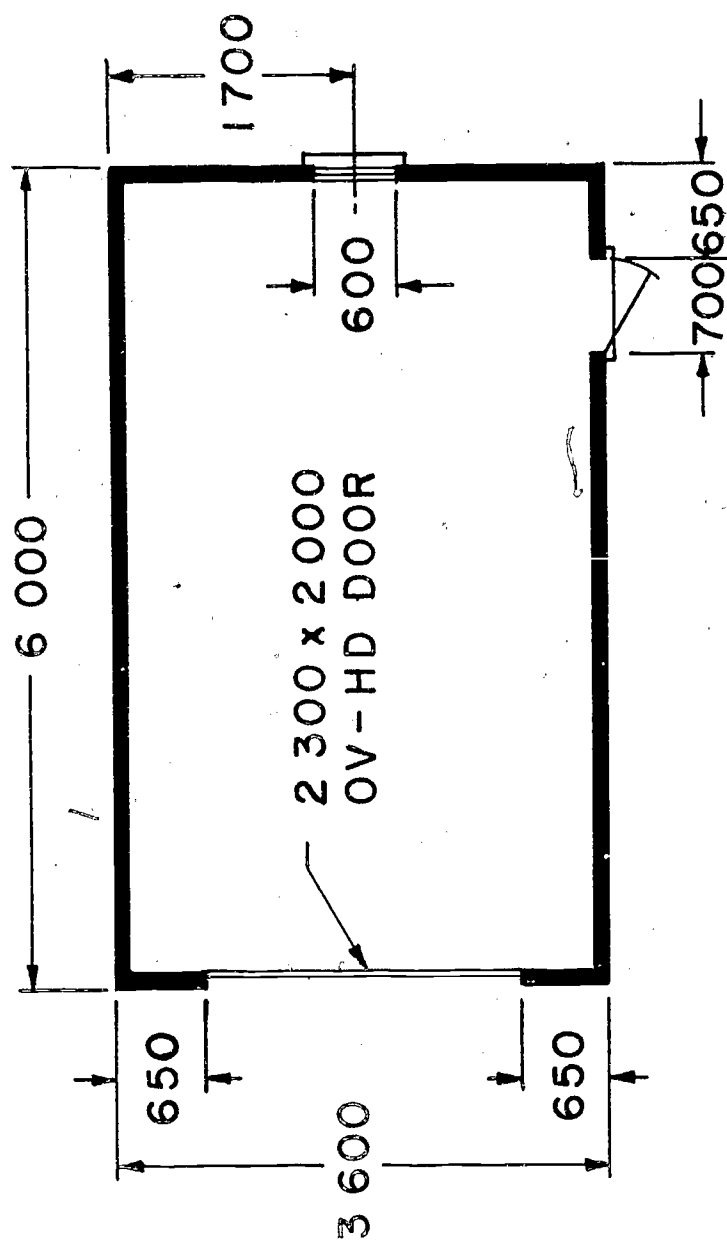
No. of Screw	Max. Head Dia. Inch	SHANK DIAMETER			ROOT DIAMETER			Thread per Inch	No. of Screw
		Basic Dec. Size Inch	Nearest Drill Equivalent Inch	mm	Average Dec. Size Inch	Nearest Drill Equivalent Inch	mm		
0	.119	.060	1/16	1.5	.040	3/64	1.0	32	0
1	.146	.073	5/64	2.0	.046	3/64	1.0	28	1
2	.172	.086	3/32	2.5	.054	1/16	1.5	26	2
3	.199	.099	7/64	3.0	.065	1/16	1.5	24	3
4	.225	.112	7/64	3.0	.075	5/64	2.0	22	4
5	.252	.125	1/8	3.5	.085	5/64	2.0	20	5
6	.279	.138	9/64	3.5	.094	3/32	2.5	18	6
7	.305	.151	5/32	4.0	.102	7/64	2.5	16	7
8	.332	.164	5/32	4.0	.112	7/64	2.5	15	8
9	.358	.177	11/64	4.5	.122	1/8	3.0	14	9
10	.385	.190	3/16	5.0	.130	1/8	3.0	13	10
11	.411	.203	13/64	5.5	.139	9/64	3.5	12	11
12	.438	.216	7/32	5.5	.148	9/64	3.5	11	12
14	.491	.242	1/4	6.5	.165	5/32	4.0	10	14
16	.544	.268	17/64	7.0	.184	3/16	4.5	9	16
18	.597	.294	19/64	7.5	.201	13/64	5.0	8	18
20	.650	.320	5/16	8.0	.223	7/32	5.5	8	20
24	.756	.372	3/8	9.5	.260	1/4	6.0	7	24

MATERIAL - PINE

ALL DIMENSIONS ARE IN mm



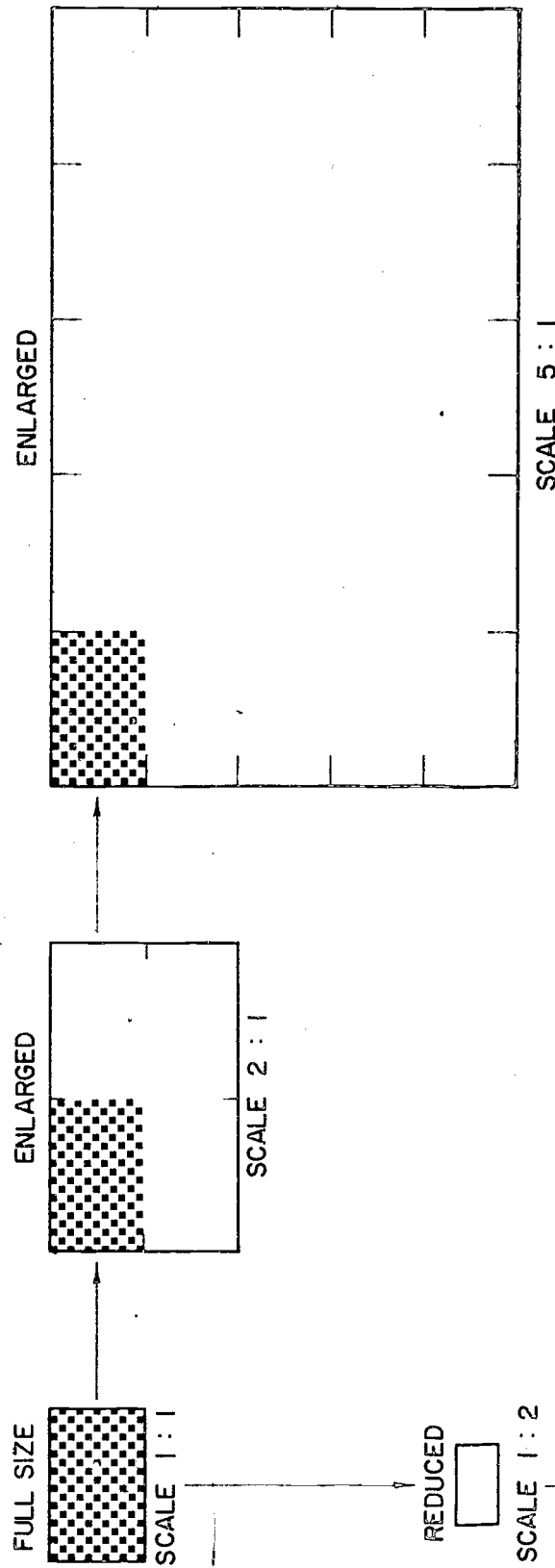
ALL DIMENSIONS IN mm  
SCALE: 1:50





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# ENLARGEMENT AND REDUCTION SCALES



THE USUAL METRIC SCALES ARE :									
FULL SIZE	1 : 1								
ENLARGEMENT	2 : 1	5 : 1	10 : 1	20 : 1	50 : 1				
REDUCTION	1 : 2	1 : 5	1 : 10	1 : 20	1 : 50				



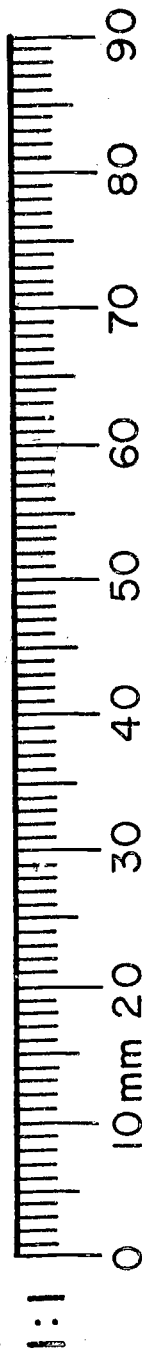
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# ARCHITECTS SCALE COMPARISON

**CUSTOMARY**



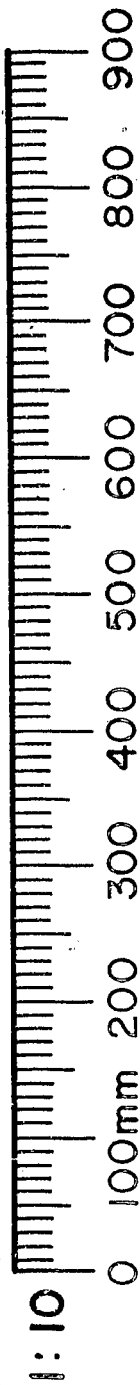
**METRIC**



**CUSTOMARY**



**METRIC**





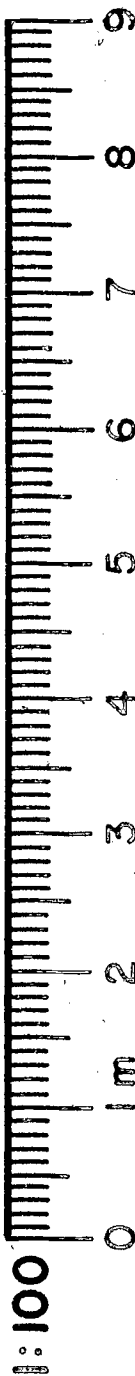
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# ARCHITECTS SCALE COMPARISON

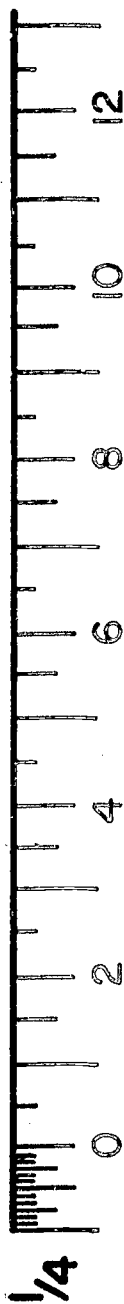
**CUSTOMARY**



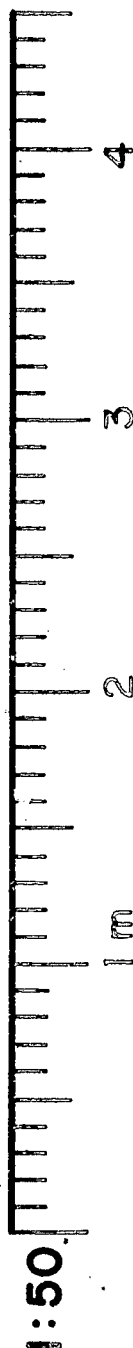
**METRIC**



**CUSTOMARY**



**METRIC**

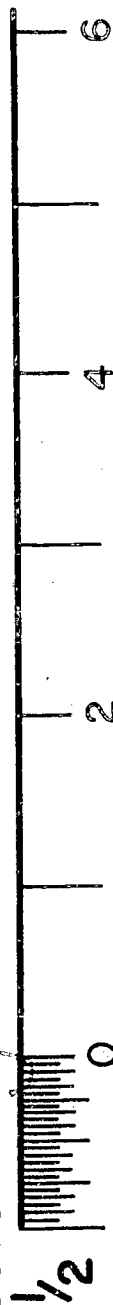




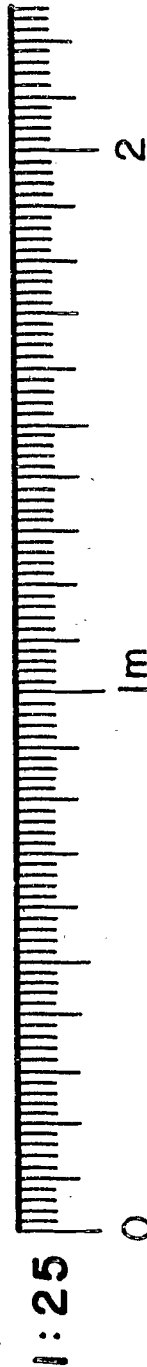
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# ARCHITECTS SCALE COMPARISON

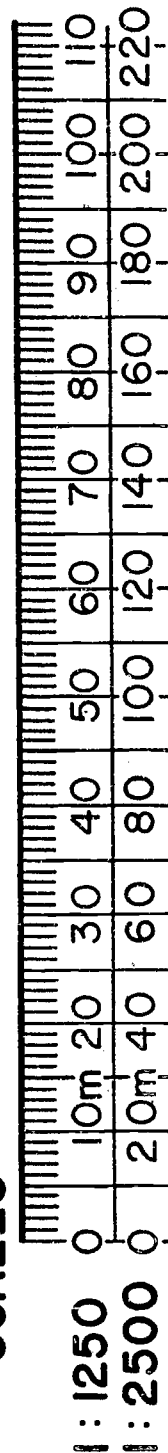
CUSTOMARY



METRIC



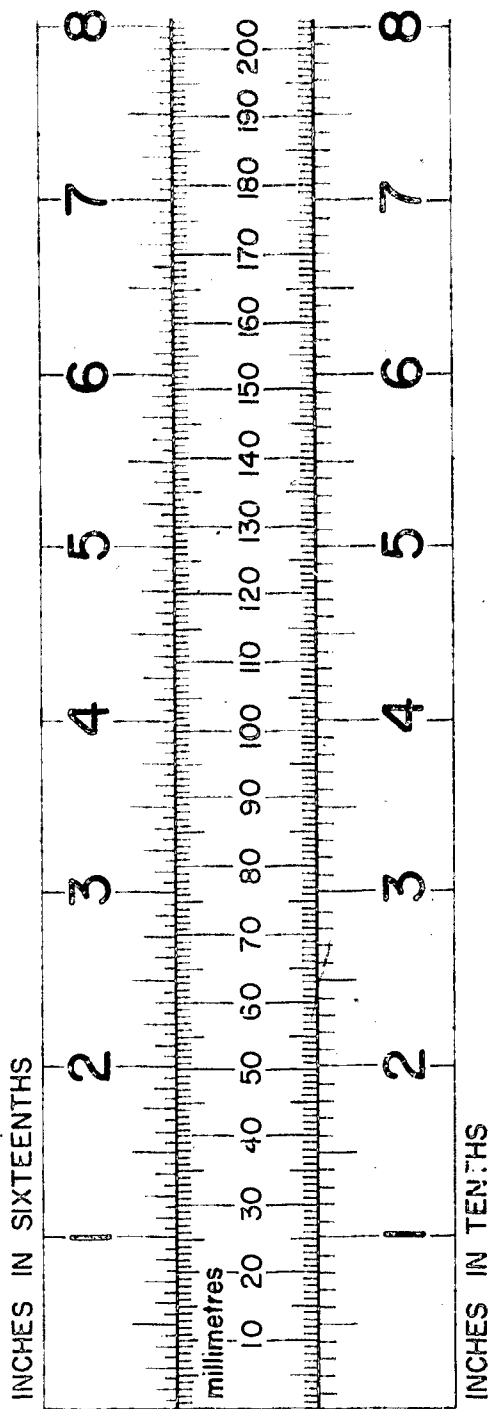
ADDITIONAL  
COMMON  
METRIC  
SCALES





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# DIRECT READING CONVERSION SCALE

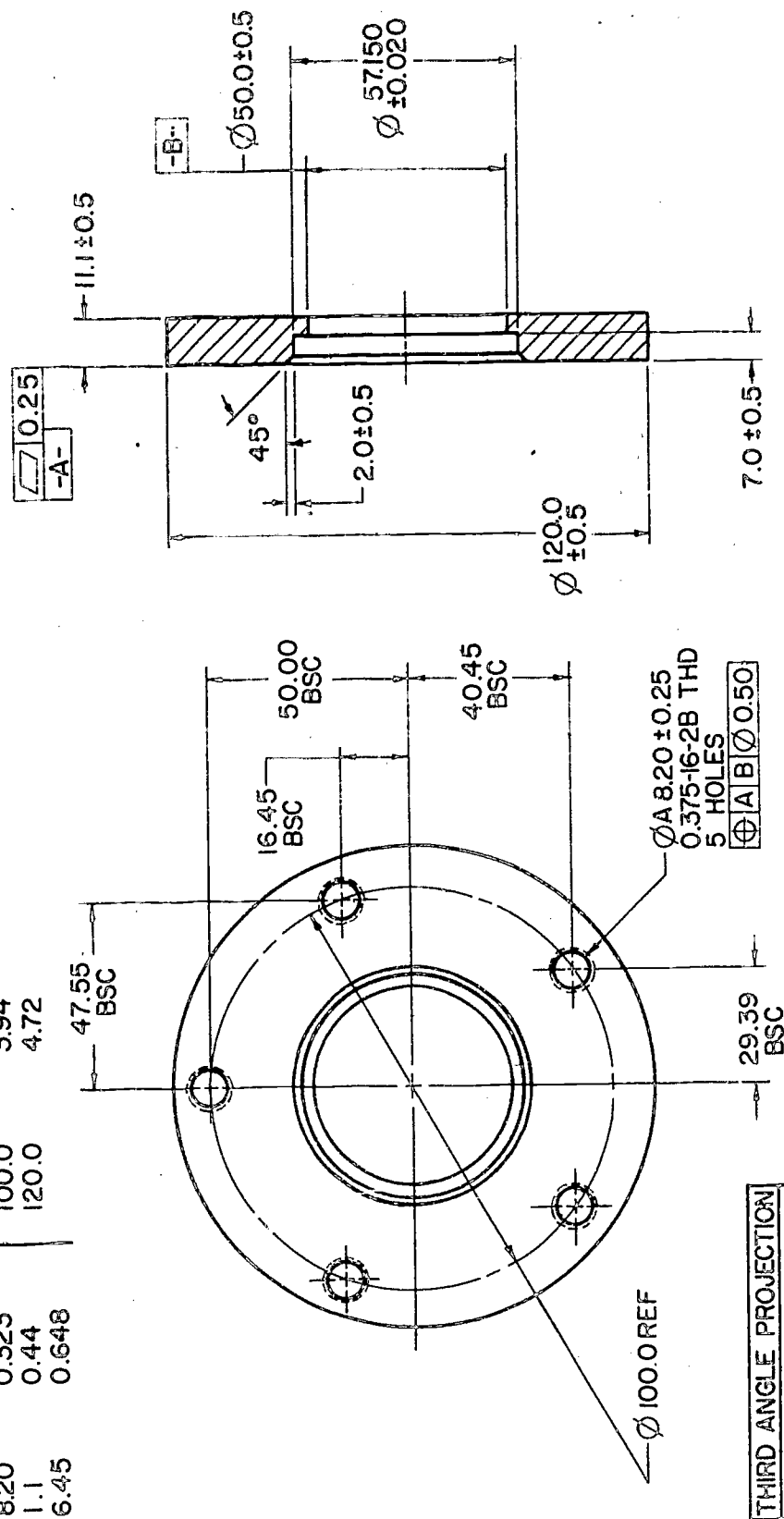






# MASTER DIMENSIONING (WITH CUSTOMARY READOUT CHART)

CONVERSION	
mm	inch
0.020	0.0008
0.25	0.010
0.5	0.02
0.50	0.020
2.0	0.08
7.0	0.28
8.20	0.323
11.1	0.44
16.45	0.648
inch	mm
1.157	29.39
1.593	40.45
1.872	47.55
1.97	50.0
1.969	50.00
2.2500	57.150
3.94	100.0
4.72	120.0

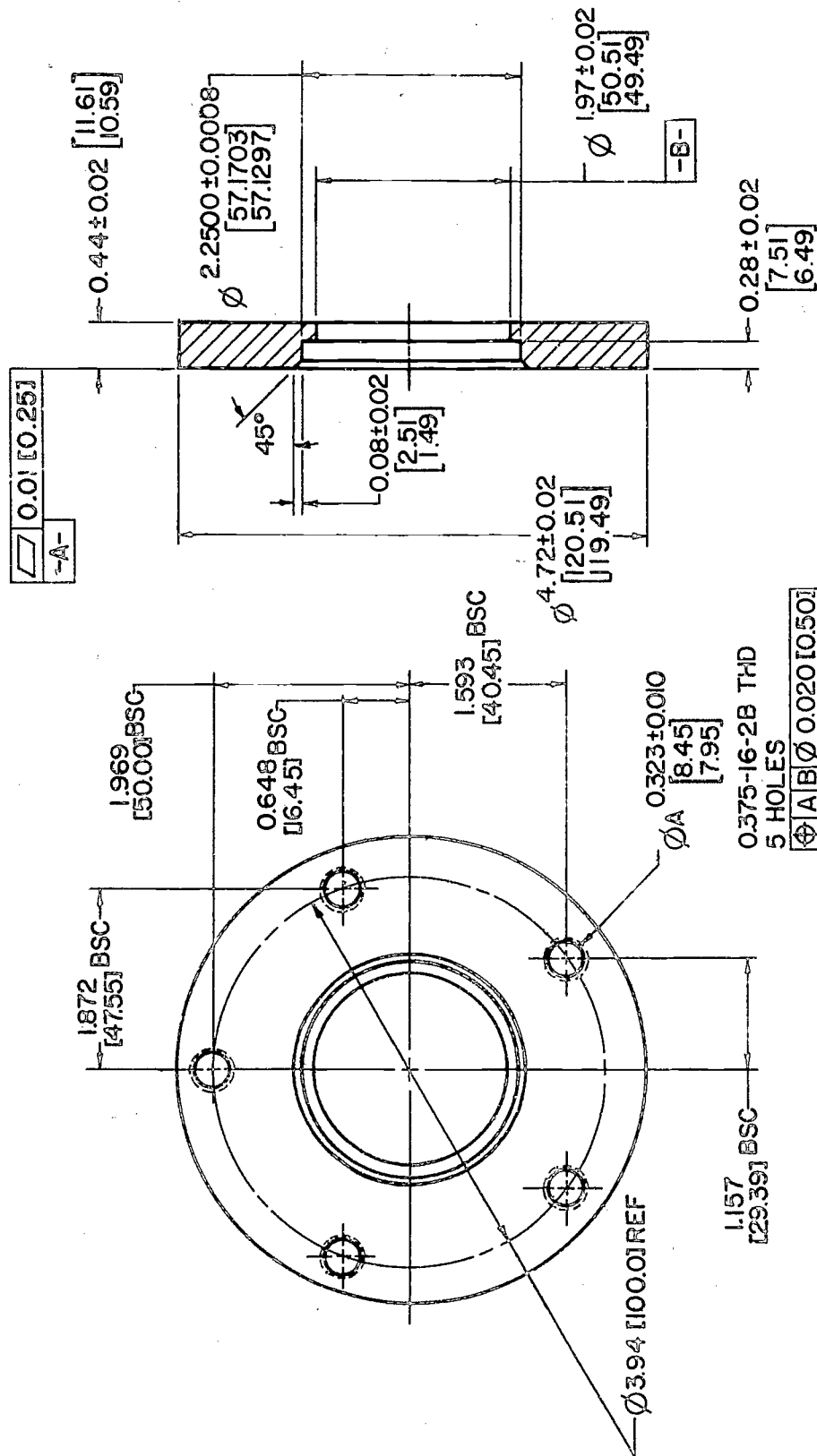


UNLESS OTHERWISE SPECIFIED:  
±1° TOL ON ANGULAR DIM.  
FINISH ALL OVER

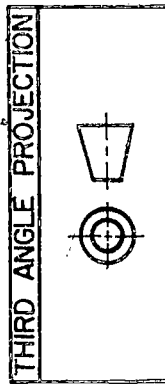
USE OF SPONSORED PROJECT. J. V. 257005  
GRANT NO. OEG-072-1859



# DUAL DIMENSIONING



DIM. IN [ ] ARE MILLIMETRES  
UNLESS OTHERWISE SPECIFIED:  
+1° TOL ON ANGULAR DIM.  
FINISH ALL OVER





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# ROUND-OFF RULES

TOTAL TOLERANCE IN INCHES		MILLIMETRE CONVERSION ROUNDED TO
AT LEAST	LESS THAN	
0.00001	0.0001	5 DECIMAL PLACES
0.0001	0.001	4 DECIMAL PLACES
0.001	0.01	3 DECIMAL PLACES
0.01	0.1	2 DECIMAL PLACES
0.1	1.0	1 DECIMAL PLACE

TOTAL TOLERANCE IN MILLIMETRES		INCH CONVERSION ROUNDED TO
0.005	0.05	5 DECIMAL PLACES
0.05	0.5	4 DECIMAL PLACES
0.5	5.0	3 DECIMAL PLACES
5.0 AND OVER		2 DECIMAL PLACES



## Fractions of an inch to millimetres

in	mm	in	mm	in	mm	in	mm	in	mm
1/64	0.016	0.397	17/64	0.266	6.747	33/64	0.516	49/64	0.766
1/32	0.031	0.794	9/32	0.281	7.144	17/32	0.531	25/32	0.781
3/64	0.047	1.191	19/64	0.297	7.541	35/64	0.547	51/64	0.797
1/16	0.062	1.588	5/16	0.312	7.938	9/16	0.562	13/16	0.812
5/64	0.078	1.984	21/64	0.328	8.334	37/64	0.578	53/64	0.828
3/32	0.094	2.381	11/32	0.344	8.731	19/32	0.594	27/32	0.844
7/64	0.109	2.778	23/64	0.359	9.128	39/64	0.609	55/64	0.859
1/8	0.125	3.175	3/8	0.375	9.525	5/8	0.625	7/8	0.875
9/64	0.141	3.572	25/64	0.391	9.922	41/64	0.641	57/64	0.891
5/32	0.156	3.969	13/32	0.406	10.319	21/32	0.656	29/32	0.906
11/64	0.172	4.366	27/64	0.422	10.716	43/64	0.672	59/64	0.922
3/16	0.188	4.762	7/16	0.438	11.112	11/16	0.688	15/16	0.938
13/64	0.203	5.159	29/64	0.453	11.509	45/64	0.703	61/64	0.953
7/32	0.219	5.556	15/32	0.469	11.906	23/32	0.719	31/32	0.969
15/64	0.234	5.953	31/64	0.484	12.303	47/64	0.734	63/64	0.984
1/4	0.250	6.350	1/2	0.500	12.700	3/4	0.750	1	1.000
									25.400



# Inches to millimetres

in	mm	in	mm	in	mm	in	mm
1	25.4	26	660.4	51	1295.4	76	1930.4
2	50.8	27	685.8	52	1320.8	77	1955.8
3	76.2	28	711.2	53	1346.2	78	1981.2
4	101.6	29	736.6	54	1371.6	79	2006.6
5	127.0	30	762.0	55	1397.0	80	2032.0
6	152.4	31	787.4	56	1422.4	81	2057.4
7	177.8	32	812.8	57	1447.8	82	2082.8
8	203.2	33	838.2	58	1473.2	83	2108.2
9	228.6	34	863.6	59	1498.6	84	2133.6
10	254.0	35	889.0	60	1524.0	85	2159.0
11	279.4	36	914.4	61	1549.4	86	2184.4
12	304.8	37	939.8	62	1574.8	87	2209.8
13	330.2	38	965.2	63	1600.2	88	2235.2
14	355.6	39	990.6	64	1625.6	89	2260.6
15	381.0	40	1016.0	65	1651.0	90	2286.0
16	406.4	41	1041.4	66	1676.4	91	2311.4
17	431.8	42	1066.8	67	1701.8	92	2336.8
18	457.2	43	1092.2	68	1727.2	93	2362.2
19	482.6	44	1117.6	69	1752.6	94	2387.6
20	508.0	45	1143.0	70	1778.0	95	2413.0
21	533.4	46	1168.4	71	1803.4	96	2438.4
22	558.8	47	1193.8	72	1828.8	97	2463.8
23	584.2	48	1219.2	73	1854.2	98	2489.2
24	609.6	49	1244.6	74	1879.6	99	2514.6
25	635.0	50	1270.0	75	1905.0	100	2540.0



# ABBREVIATIONS

(SOME FORMER ABBREVIATIONS ARE NOW SYMBOLS)

Across flats	ACR FLT	Inside diameter	ID
Centers	CTR	Left hand	LH
Center line	CL	Material	MATL
Centimetre	cm	Metre	m
Chamfer	CHAM	Millimetre	mm
Counterbore	CBORE	Number	NO
Countersink	CSK	Outside diameter	OD
Countersunk head	CSK H	Pitch diameter	PD
Diameter (before the dimension)	Ø	Radius (before the dimension)	R
Diameter (in a note)	DIA	Right hand	RH
Drawing	DWG	Round	RD
Figure	FIG	Square (before the dimension)	□
Hexagon	HEX	Square (in a note)	SQ
Hexagonal head	HEX HD	Thread	THD

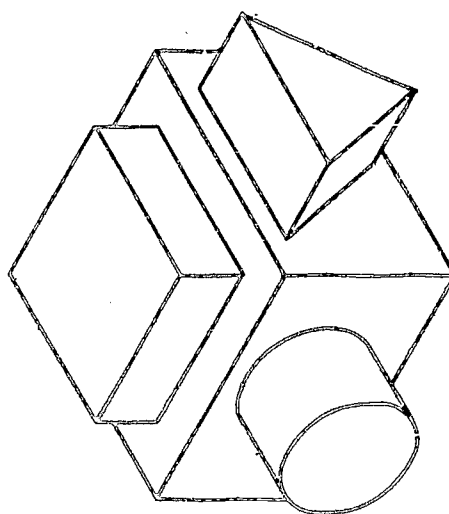
## ORTHOGRAPHIC PROJECTION COMPARISON

First-angle projection isn't a metric method of drawing but a consequence of international standards. One of the main reasons metrication is taking place in the United States is to facilitate communication on the international level. Since many European countries draw in first-angle projection, it is important for the students to at least get a basic exposure to first-angle projection. The difference between first and third angle projection is that in first-angle the object as viewed is projected onto the drawing surface, while in third-angle the object is drawn as viewed. A careful study of this transparency will clarify this idea. A metric drawing should specify first or third-angle projection, as indicated on the transparency.

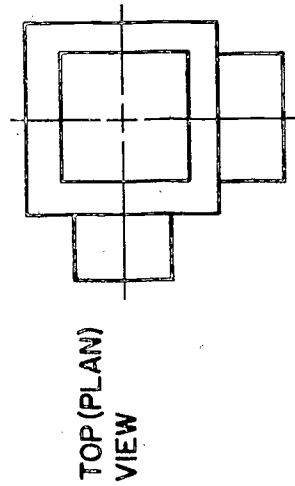
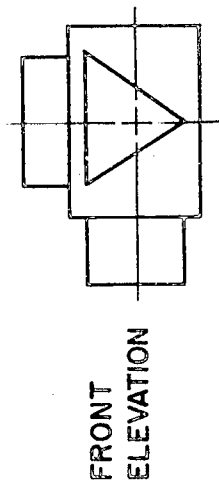
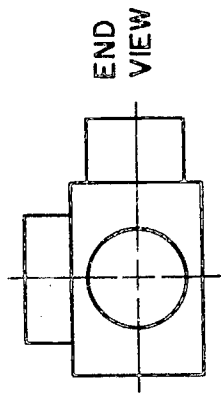
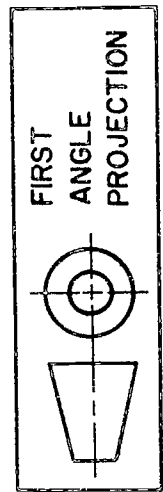


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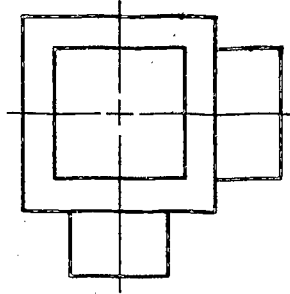
# ORTHOGRAPHIC PROJECTION COMPARISON



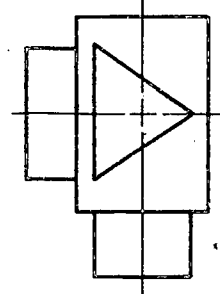




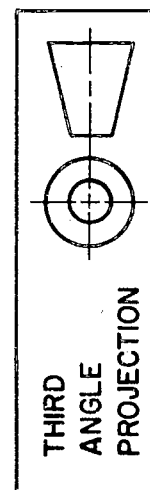
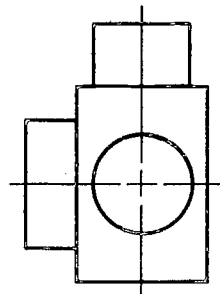
TOP (PLAN)  
VIEW



FRONT  
ELEVATION



END  
VIEW

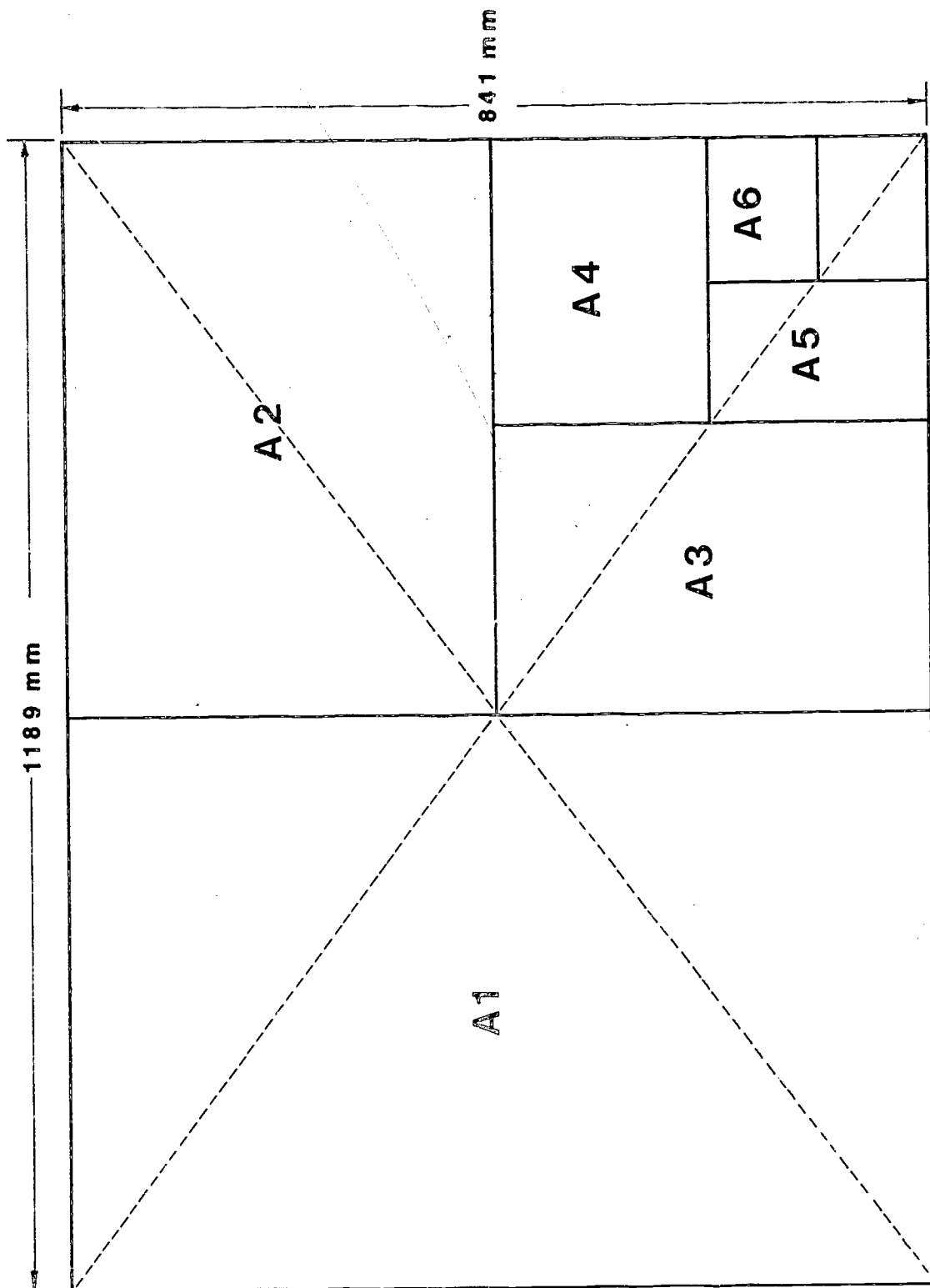


THIRD  
ANGLE  
PROJECTION



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## ISO - A SIZE PAPER



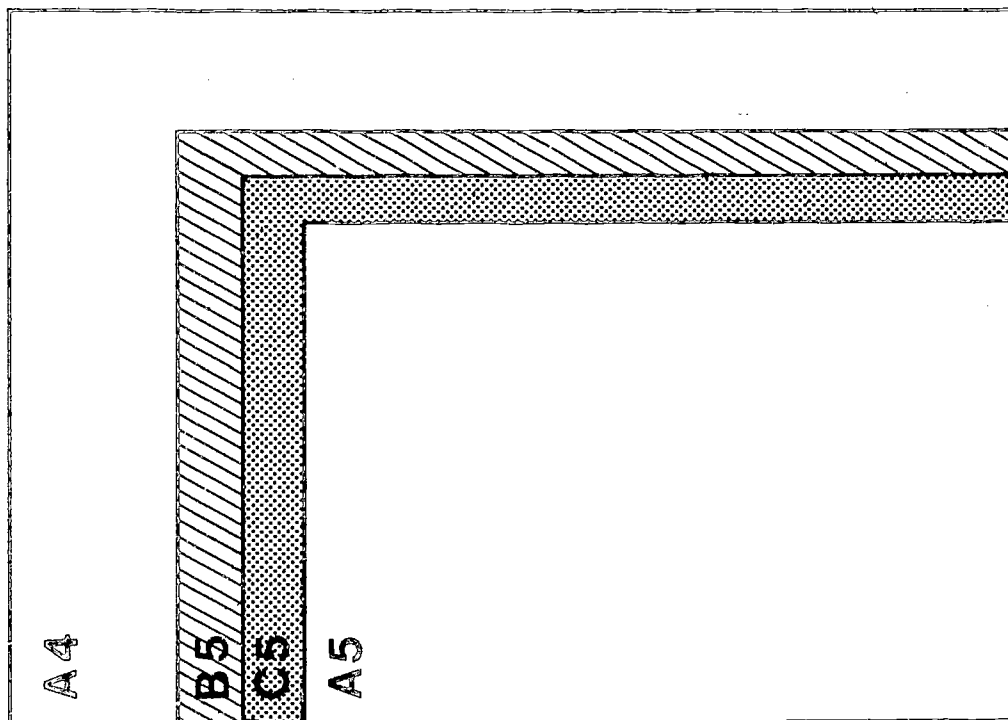
1189 mm x 841 mm = 1 SQUARE METRE

USOE SPONSORED PROJECT NO. V257006  
GRANT NO. O EG-G72-1868



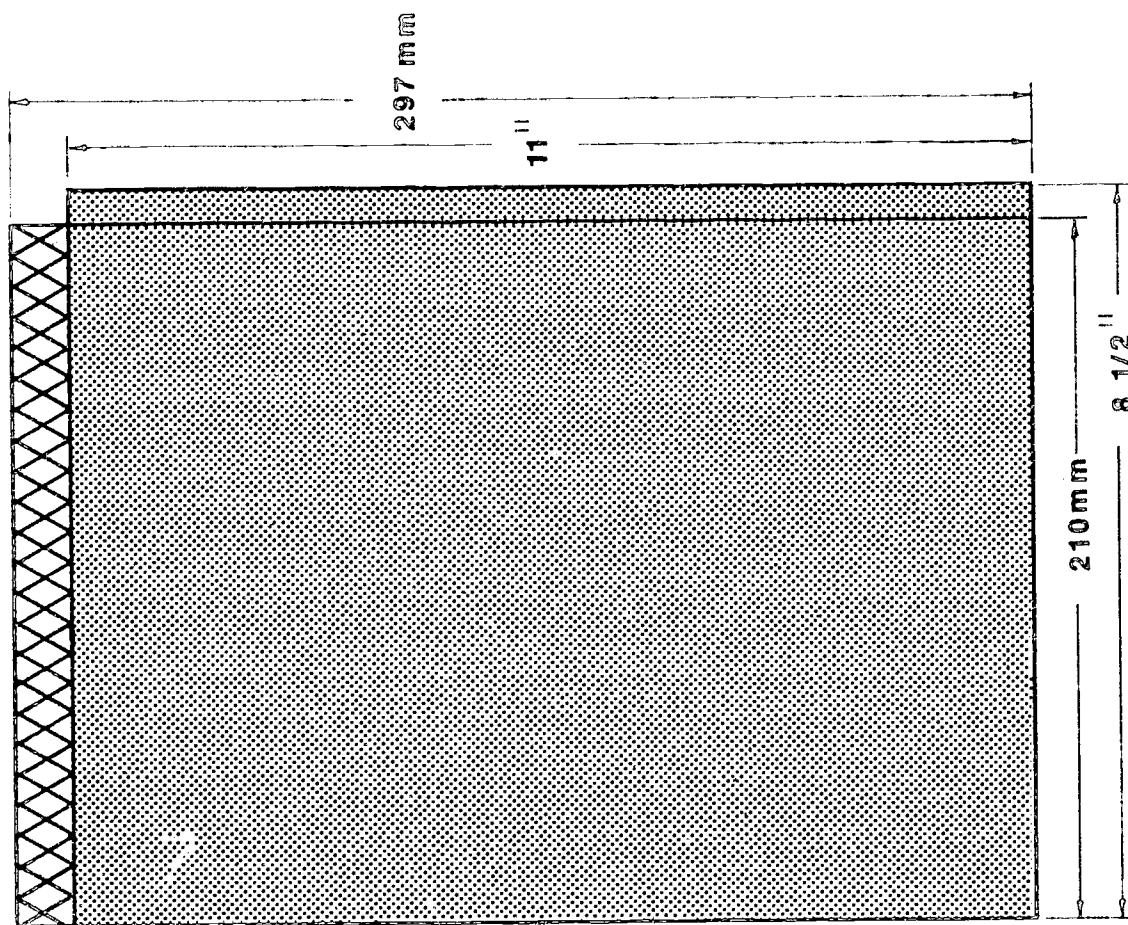
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## RELATIONSHIP BETWEEN A, B, AND C SIZE PAPER





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COMPARING 8 1/2 x 11 TO ISO A4 SIZE PAPER

USOE SPONSORED PROJECT NO. V257006  
GRANT NO. O EG-Q-72-1868



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## STOCK SIZES - FOR A SERIES PAPER

### Sizes for Normal Trims

ISO - size	METRIC - millimetres	CUSTOMARY - inches
RAO	860 x 1220	33.86 x 48.03
RA1	610 x 860	24.02 x 33.86
RA2	430 x 610	16.93 x 24.02

### Sizes for Bleed Work or Extra Trims

ISO - size	METRIC - millimetres	CUSTOMARY - inches
SRAO	900 x 1280	35.43 x 50.39
SRA1	640 x 900	25.20 x 35.43
SRA2	450 x 640	17.72 x 25.20



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## COMPARISON CHART - A SIZE PAPER

ISO-sizes	METRIC-millimetres	CUSTOMARY-inches
2A	1189 x 1682	46.81 x 66.22
A0	841 x 1189	33.11 x 46.81
A1	594 x 841	23.39 x 33.11
A2	420 x 594	16.54 x 23.39
A3	297 x 420	11.69 x 16.54
A4	210 x 297	8.27 x 11.69
A5	148 x 210	5.83 x 8.27
A6	105 x 148	4.13 x 5.83
A7	74 x 105	2.91 x 4.13
A8	52 x 74	2.05 x 2.91
A9	37 x 52	1.46 x 2.05
A10	26 x 37	1.02 x 1.46



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# COMPARISON CHART - B SIZE PAPER

ISO-sizes	METRIC-millimetres	CUSTOMARY-inches
B0	1000 x 1414	39.37 x 55.67
B1	707 x 1000	27.83 x 39.37
B2	500 x 707	19.68 x 27.83
B3	353 x 500	13.90 x 19.68
B4	250 x 353	9.84 x 13.90
B5	176 x 250	6.93 x 9.84
B6	125 x 176	4.92 x 6.93
B7	88 x 125	3.46 x 4.92
B8	62 x 88	2.44 x 3.46
B9	44 x 62	1.73 x 2.44
B10	31 x 44	1.22 x 1.73





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## R20 SERIES OF PAPER WEIGHTS AND EQUIVALENT WEIGHTS

'R' series	Bond		Cover		Index	Newsprint		Book
	17 x 22	20 x 26	25 1/2 x 30 1/2	24 x 36				
	432 x	508 x	648 x	610 x				
	559 mm	660 mm	775 mm	914 mm				
g/m <sup>2</sup>	lb/ream	lb/ream	lb/ream	lb/ream	lb/ream	lb/ream	lb/ream	
20.0	5.32	7.39	11.00	12.29		13.51		
22.4	5.95	8.28	12.39	13.77		15.13		
25.0	6.65	9.24	13.83	15.36		16.89		
28.0	7.44	10.35	15.49	17.21		18.92		
31.5	8.37	11.65	17.43	19.36		21.28		
45.0	11.97	16.64	24.89	27.66		30.40		
50.0	13.30	18.49	27.66	30.73		33.78		
56.0	14.89	20.71	30.98	34.42		37.84		
63.0	16.75	23.30	34.85	38.72		42.57		
71.0	18.88	26.26	39.28	43.63		47.97		
85.0	22.61	31.45	46.90	52.27		57.46		
100.0	26.60	36.98	55.32	61.46		67.57		
112.0	29.79	41.42	61.96	68.83		75.68		
140.0	37.24	51.78	77.45	86.04		94.60		
180.0	47.68	66.57	99.58	110.62		121.63		
200.0	53.20	73.97	110.64	122.91		135.14		
250.0	66.50	92.46	138.30	153.64		168.93		
400.0	106.41	147.95	221.29	245.83		270.29		



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# **PRINTER'S UNITS CUSTOMARY & METRIC EQUIVALENTS**

<b>PRINTER'S</b>			<b>CUSTOMARY—INCHES</b>		<b>METRIC—millimetres</b>
Picas	Points	Approximate Fraction	Decimal		
1	1	1/64	.014	.35	
	2	1/32	.028	.70	
	3	3/64	.042	1.05	
	4	7/128	.055	1.40	
	5	1/16	.069	1.75	
	6	5/64	.083	2.10	
	7	3/32	.097	2.45	
	8	7/64	.111	2.80	
	9	1/8	.125	3.15	
	10	9/64	.138	3.50	
2	12	21/128	.166	4.20	
	14	25/128	.194	4.90	
	18	1/4	.249	6.30	
	24	21/64	.332	8.40	
3	30	53/128	.414	10.50	
	36	1/2	.498	12.60	
	42	37/64	.581	14.70	
	48	85/128	.664	16.80	
4	60	53/64	.828	21.00	
	72	1	.996	25.20	



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# METRIC UNITS PRINTER'S & CUSTOMARY EQUIVALENTS

METRIC-millimetres	PRINTER'S		CUSTOMARY-inches
	Points	Approximate Picas + Points	
1	2.86		.039
2	5.71		.079
3	8.57		.118
4	11.43		.157
5	14.29	1 + 2¼	.197
6	17.14	1 + 5	.236
7	20.00	1 + 8	.276
8	22.86	1 + 10¾	.315
9	25.71	2 + 1½	.354
10	28.57	2 + 4½	.394
15	42.86	3 + 6¾	.591
20	57.14	4 + 9	.787
25	71.43	5 + 11	.984
30	85.71	7 + 1¼	1.181
35	100.00	8 + 3½	1.378
40	114.28	9 + 5¾	1.575
45	128.57	10 + 4	1.772
50	142.85	11 + 6¼	1.969
75	214.28	17 + 5¼	2.953
100	285.71	23 + 8½	3.937



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## SCREEN RULINGS

Customary Rulings      Metric Rulings  
per inch      per centimetre

50	20
65	26
75	30
100	40
120	48
133	54
150	60
175	70
200	80